

CORRELATION BETWEEN SPINAL COLUMN LENGTH AND THE SPREAD OF SUBARACHNOID HYPERBARIC BUPIVACAINE IN THE TERM PARTURIENT

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HOW TO CITE THIS ARTICLE:

Ashok V. Deshpande, Sanjeevani A. Deshpande, U. T. Bhosale. "Correlation between Spinal Column Length and The Spread of Subarachnoid Hyperbaric Bupivacaine in the term Parturient". Journal of Evolution of Medical and Dental Sciences 2014; Vol. 3, Issue 11, March 17; Page: 2892-2897, DOI: 10.14260/jemds/2014/2221

ABSTRACT: BACKGROUND: Anesthesiologist frequently tailors the subarachnoid local anesthetic dosage according to parturient height to achieve sensory blockade up to the T4 dermatome for lower segment Caesarean sections (LSCSs). Studies that have been conducted have demonstrated that height does not affect the spread of subarachnoid hyperbaric bupivacaine. This study aimed to find the correlation between the spinal column length of term parturient and the highest level of sensory blockade after spinal anesthesia. **METHODS:** This study is conducted at the Sanjeevan Hospital Neminath Nagar Sangli, Maharashtra India from January 2004 to December 2013 The authors studied 138 term parturient of American Society of Anesthesiologists (ASA) physical status I or II scheduled for elective LSCSs. The length of the spinal column was taken as an average of three measurements from the C7 spinous process to the sacral hiatus in a sitting upright and facing forward position. Spinal anesthesia was given by administering 1.8 ml of 0.5% hyperbaric bupivacaine through the L3/L4 or L4/L5 intervertebral space. The level of sensory blockade was assessed using pin-prick testing for pain sensation. Linear regression analysis was used to analyze the correlation; $R < 0.25$ indicates no correlation with the level of significance being < 0.05 . **RESULTS:** The spinal column lengths measured were between 42.2 cm and 85.8 cm (median: 58.5 cm). Spinal anesthesia given was adequate for all patients, with the highest levels of anesthesia ranging from T8 to T2 with sensory levels between T6 and T4. The parturient spinal column length showed no correlation with the highest level of sensory blockade achieved, namely $R = 0.11$. **CONCLUSIONS:** The study found no correlation between the parturient spinal column length and the highest level of sensory blockade achieved.

KEYWORDS: Hyperbaric bupivacaine; Lower segment Caesarean section (LSCS) Parturient; Spinal anesthesia; Spinal column;

INTRODUCTION: Spinal anesthesia, which blocks the nerve roots as they course through the subarachnoid space, has become the preferred technique for lower segment Caesarean sections (LSCSs). This is because general anesthesia is associated with a higher incidence of pulmonary aspiration of gastric contents and failed endotracheal intubations compared to other types of surgery, causing higher rates of morbidity and mortality. Furthermore, spinal anesthesia offers less neonatal exposure to potentially depressant drugs and allows early bonding between mothers and their babies, as mothers are awake throughout the procedure¹ Caesarean sections require sensory blockade up to the T4 dermatome level, as this not only blocks the somatic sensations of the Caesarean sections but also eliminates the visceral pain from peritoneal manipulation ¹Subarachnoid local anesthetics provide rapid and profound anesthesia for Caesarean sections; however, the final spread of spinal anesthesia is unpredictable² Greene commented that "common sense and clinical experiences" dictate that a shorter patient is associated with a more cephalad spread of the

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subarachnoid local anesthetics in comparison to a taller patient.³ In his review, he did not consider the possibility of spinal column length affecting the spread of subarachnoid local anesthetics. Later, Norris demonstrated that within commonly encountered ranges of height and weight in term parturient, the height and weight do not affect the spread of subarachnoid hyperbaric bupivacaine.⁴ Up to date, many anesthetists in clinical practice still tailor their subarachnoid local anesthetic dosage according to the parturient' height, as common sense still influences our clinical practice. Therefore, this study was carried out to assess whether the length of the spinal column of term parturient influences the highest level of sensory blockade achieved.

MATERIALS AND METHODS: After obtaining consent, 138 term parturient of American Society of Anesthesiologists (ASA) physical status I or II scheduled for elective LCSCs were enrolled in the study. Distribution of the patients according to age is shown in Table No 1. Patients included in the study were from 17 years to 30 years.

S. No.	Age group in Yrs.	No. of patient
1	18 -- 20	32
2	20 - 25	69
3	26 -- 30	37

Table 1: Age incidence

Criterion of Exclusion:

1. Younger than 18 years
2. Gestational age less than 36 weeks
3. Diabetes, PIH, Cardiac and other inter current diseases
4. Spine abnormalities
5. Usual contraindications for spinal

Apart from the usual contraindications to spinal anesthesia, patients younger than 18 years old and those with a gestational age of less than 36 weeks and any abnormalities of the spine were excluded. Prior to the induction of spinal anesthesia, all parturient fasted for six hours and were only allowed clear fluids up to two hours prior to the surgery. Oral ranitidine of 150 mg was given the night before and on the morning of surgery. Upon arrival at the operating theatres, standard non-invasive monitoring and intravenous infusion of 500 ml of Ringer's lactate solution were commenced. The length of the spinal column was measured by a single operator before spinal anesthesia was given. The length of the spinal column was taken as an average of three measurements from the C7 spinous process to the sacral hiatus using a standard measuring tape while in a sitting upright and facing forward position, with the legs horizontally on the operating room table.

S. No.	Length in cms	No. of patient
1	41 -- 50	32
2	51 -- 60	68
3	61 -- 70	38

Table 2: Incidence of length of spinal column

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After the measurement, spinal anesthesia was given under aseptic technique in the same sitting position. The skin was infiltrated with local anesthetic (lignocaine 2%) prior to the 24-G spinal needle insertion. The spinal needle was advanced between the L3/L4 or L4/L5 intervertebral space with the needle opening facing cephalad. Once a free flow of cerebrospinal fluid was evident, 1.8 ml of 0.5% hyperbaric bupivacaine (9 mg) was injected over five seconds into the subarachnoid space. After spinal anesthesia was given, the patients were placed in the horizontal supine position with left uterine displacement with a 15° left lateral tilt of the operating table. Oxygen at 5 L/min was administered via a face mask to all patients as standard protocol until delivery.

Five minutes after spinal anesthesia was given, the highest level of sensory blockade was determined using a 23-G needle at 5 five-minute intervals for the first thirty minutes and thereafter every 15 fifteen minutes until sixty minutes of spinal injection had lapsed. Demographic variables (age, height, weight, ethnicity, parity and indication for Caesarean section) were also recorded. Linear regression analysis was used to analyze whether any correlation exists between the highest level of sensory blockade achieved and the parturient spinal column length. R less than 0.25 indicates no correlation, with the level of significance being less than 0.05.

RESULTS: A total of 138 parturient were studied, and their measured spinal column lengths were between 42.2 cm and 68.6 cm. Spinal anesthesia given was adequate for all Caesarean sections with the highest levels of anesthesia ranging from T8 to T2 with sensory levels more commonly blocked between T6 and T4. The highest sensory blockade was taken as when two consecutive levels of sensory blockade achieved were identical. The parturient spinal column length showed no correlation with the highest level of sensory blockade achieved. Every centimeter change in the parturient spinal column length will result in a change of the three sensory level blockades achieved.

S. No.	Thoracic Vertebral Level	No. of Patient	Percentage
1	T 2	04	02.89 %
2	T 3	14	10.14 %
3	T4	46	33.33 %
4	T5	21	15.21 %
5	T6	36	26.08 %
6	T7	09	06.52 %
7	T 8	08	05.79 %

Table 3: Percentage of the highest level achieved

DISCUSSION: Greene, in his review, listed 25 factors that could possibly influence the distribution of subarachnoid local anaesthetics.³ He identified 11 factors that demonstrably affect the distribution of subarachnoid local anesthetics with varying clinical significance. The factors were the patient's age, height, anatomic configuration of the spinal column, the site on injection, the direction of the needle during the injection, the volume of cerebrospinal fluid (CSF), the density of CSF, the density and baricity of the anesthetic solution injected, the position of the patient (with hypo- or hyperbaric solutions), the dosage of local anesthetic and the volume of anesthetic solution injected. Recently, Pitkänen and Rosenberg reviewed these factors, and concluded that in clinical practice the spread of

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subarachnoid local anesthetics is best controlled by choosing the dose and baricity of the local anesthetic, and the position of the patient⁵ As mentioned above, the dose of local anesthetic used influences the spread of local anesthetics in the subarachnoid space. In this study, the highest level of sensory blockade achieved was between the T8 and T2 dermatome level, whereas Norris found the level to be between T10 and C4.⁶ The higher level of sensory blockade achieved is explained by the higher dose of hyperbaric bupivacaine (15 mg) used in Norris's study. In another study by Kiran and Singal, hyperbaric subarachnoid dosages used were about the same (7.5 mg, 8.75 mg and 10 mg) as in the current study, and they achieved similar higher levels of sensory blockade, which was between T7 and T1.

They concluded that the use of higher doses of local anesthetics had an advantage of prolonging analgesia at the expense of increasing the incidence of side effects.⁷ Pitkänen and Rosenberg also concluded that patient's position during and immediately after the subarachnoid injection affect the spread of subarachnoid hyperbaric bupivacaine.⁵ However; their review was not specifically focused on the parturient population while Russell et al demonstrated that varying positions (Oxford, lateral and sitting) of parturient during the induction of spinal anesthesia do not affect the spread of subarachnoid hyperbaric bupivacaine.⁸ Therefore; the sitting position that was used in the current study for the induction of spinal anesthesia should not confound the results of the study. Greene did mention that sites of subarachnoid injection of local anesthetics above the L2/L3 inter vertebral spaces cause a greater shift in the cephalad direction. He attributed this greater cephalad spread to the lesser volume of CSF per spinal cord segment above L2, as the spinal cord ends at L2 in adults.³ However, Pitkänen and Rosenberg concluded that for patients in the sitting position during the subarachnoid injections, the difference in the highest level of sensory blockade achieved were small if the L2/L3 inter vertebral spaces were used in comparison to L4/L5.⁵

In the current study, two sites of injection were used, either the L3/L4 or the L4/L5 inter vertebral spaces. As concluded by Pitkänen and Rosenberg, this factor should not affect the highest level of sensory blockade achieved in this study. Kitahara et al demonstrated that radio-labeled hyperbaric local anesthetics move by bulk flow with gravity to dependent areas of the spine.⁹ Barker modeled the cadaveric spinal canal using glass tubes and methyl violet blue and demonstrated that hyperbaric local anesthetic pools in the dependent part of the spinal column, which was T5 or T6.¹⁰ However, Hirabayashi et al, using magnetic resonance imaging, found the lowest point of the thoracic spinal canal to be located at T8.¹¹ Furthermore, the upper lumbar and lower thoracic spinal canal is inclined eight to twelve degrees to the horizontal when patients are supine.² Based on these arguments, it may suggest that the subarachnoid hyperbaric bupivacaine most likely pools in the lowest part of the thoracic spine, which may explain the findings of this study.

Therefore, despite the large variation of spinal column length encountered the highest level of sensory blockade achieved remains between T4 and T6. Unfortunately, none of the above studies were done on the term parturient and, furthermore, in the current study patients were placed in a left lateral tilt position after the spinal anesthesia, which may further affect the pattern of spread of the hyperbaric bupivacaine. Further studies need to be designed to find the correlation between the lowest points of the thoracic spine and the highest level of sensory blockade in term parturient. Both spinal column anatomical limitations and the physics of hyperbaric local anesthetic spread in the spinal canal may account for the inability of this study to demonstrate any correlation between spinal column length and the highest level of sensory blockade achieved. Norris was also unable to

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demonstrate a correlation between spinal column length and the highest level of sensory blockade achieved⁶ On the other hand, Hartwell et al found a weak but statistically significant correlation between spinal column length and the highest level of sensory blockade achieved¹³ In their study, 10 to 15% of the variation seen in the highest level of sensory blockade achieved was attributed to knowledge of the parturient spinal column length. However, Hartwell et al study demonstrated high levels of highest level of sensory blockade achieved (T4 to C5).

In view of the very high level of sensory blockade along with a narrow range of sensory blockade, they were unable to indicate spinal column length as a good predictor of spread of hyperbaric bupivacaine in the subarachnoid space. Furthermore, they were unable to explain the very high level of sensory blockade achieved in their study. We in our study found that among 138 patients the spinal column length was in the range of 51 to 60 cms in 68 patients. We attribute this to the average Indian population height is less. The sensory level of the anesthetic was upto T4 in 33.33 % patients in spite of being 68 patients in the 51 to 60 cms group and up to T6 in 26.08 % patients. So though there are 50 % patients in the group with 51 to 60 cms spinal length but the T4 level is achieved by only 33.33 % patients which need not be from the same group.. The ideal level required is T4 to relieve the visceral pain during the washing of the abdomen in LSCS. At the end we also determined that there is no correlation between the length of the spinal column and the highest level of the sensory blockade.

CONCLUSION: The authors concluded that there is no correlation between the parturient spinal column length and the highest level of sensory blockade achieved.

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Date of Submission: 28/02/2014.

Date of Peer Review: 01/03/2014.

Date of Acceptance: 06/03/2014.

Date of Publishing: 14/03/2014.