

## Correlation between spinal column length and the spread of subarachnoid hyperbaric bupivacaine in the term parturient

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### Abstract

**Background:** Anaesthetists frequently tailor the subarachnoid local anaesthetic 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 parturients and the highest level of sensory blockade after spinal anaesthesia.

**Methods:** The authors studied 60 singleton term parturients 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 anaesthesia was given by administering 1.8 ml of 0.5% hyperbaric bupivacaine and 25 µg fentanyl 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 analyse 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 anaesthesia given was adequate for all patients, with the highest levels of anaesthesia ranging from T8 to T2 with sensory levels between T6 and T4. The parturients' 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 parturients' spinal column length and the highest level of sensory blockade achieved.

### Introduction

Spinal anaesthesia, 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 anaesthesia 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 anaesthesia offers less neonatal exposure to potentially depressant drugs and allows early bonding between mothers and

their babies, as mothers are awake throughout the procedure.<sup>1</sup>

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.<sup>1</sup> Subarachnoid local anaesthetics provide rapid and profound anaesthesia for Caesarean sections; however, the final spread of spinal anaesthesia is unpredictable.<sup>2</sup>

Greene commented that "common sense and clinical experiences" dictate that a shorter patient is associated

with a more cephalad spread of the subarachnoid local anaesthetics in comparison to a taller patient.<sup>3</sup> In his review, he did not consider the possibility of spinal column length affecting the spread of subarachnoid local anaesthetics. Later, Norris demonstrated that within commonly encountered ranges of height and weight in term parturients, the height and weight do not affect the spread of subarachnoid hyperbaric bupivacaine.<sup>4</sup> Up to date, many anaesthetists in clinical practice still tailor their subarachnoid local anaesthetic dosage according to the parturient's 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 parturients influences the highest level of sensory blockade achieved.

### Materials and methods

After obtaining the approval of the Dissertation Committee, Department of Anaesthesiology and Intensive Care, Faculty of Medicine, Universiti Kebangsaan, Malaysia and informed consent, 60 singleton term parturients of American Society of Anesthesiologists (ASA) physical status I or II scheduled for elective LCSCs were enrolled in the study. Apart from the usual contraindications to spinal anaesthesia, 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 anaesthesia, all parturients 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, the parturients were given 30 ml of 0.3 M sodium citrate. 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 anaesthesia 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.

After the measurement, spinal anaesthesia was given under aseptic technique in the same sitting position. The skin was infiltrated with local anaesthetic (lignocaine 2%) prior to the 27-G pencil-point spinal needle insertion.

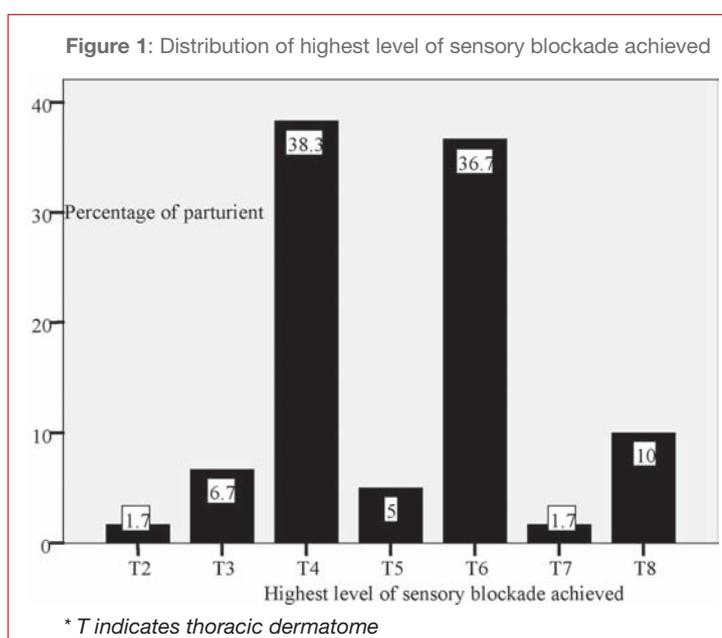
The spinal needle was advanced between the L3/L4 or L4/L5 intervertebral space with the pencil-point needle opening facing cephalad. Once a free flow of cerebrospinal fluid was evident, 1.8 ml of 0.5% hyperbaric bupivacaine (9 mg) and 25 µg fentanyl (total volume 2.3 ml) were injected without barbotage over five seconds into the subarachnoid space. After spinal anaesthesia 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 anaesthesia was given, the highest level of sensory blockade was determined using a 23-G needle at five-minute intervals for the first thirty minutes and thereafter every 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 analyse whether any correlation exists between the highest level of sensory blockade achieved and the parturients' 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 60 parturients were studied, and their measured spinal column lengths were between 42.2 cm and 85.8 cm with a median length of 58.5 cm. Spinal anaesthesia given was adequate for all Caesarean sections with the highest levels of anaesthesia ranging from T8 to T2 with



sensory levels more commonly blocked between T6 and T4 (Figure 1). The highest sensory blockade was taken as when two consecutive levels of sensory blockade achieved were identical.

As shown in Figure 2, the parturients' spinal column length showed no correlation with the highest level of sensory blockade achieved, namely  $R = 0.11$ . Every centimetre change in the parturients' spinal column length will result in a change of the three sensory level blockades achieved.

## Discussion

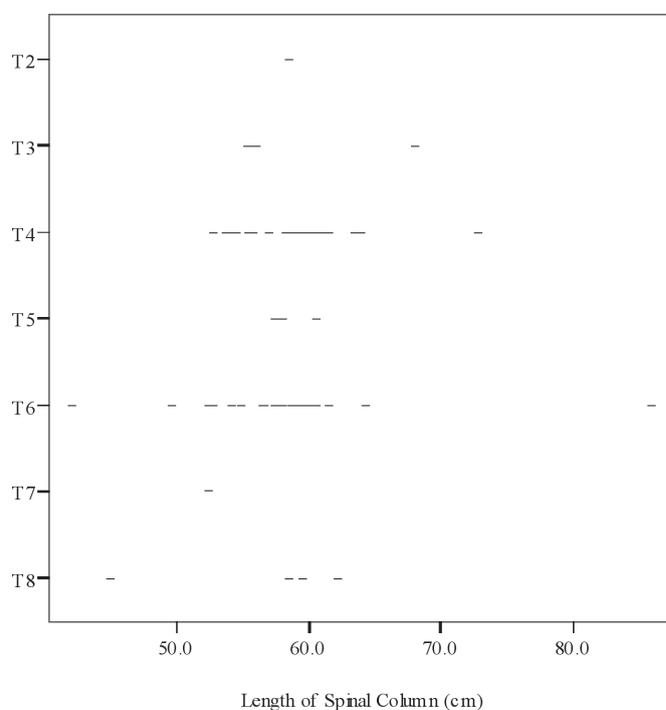
Greene, in his review, listed 25 factors that could possibly influence the distribution of subarachnoid local anaesthetics.<sup>3</sup> He identified 11 factors that demonstrably affect the distribution of subarachnoid local anaesthetics with varying clinical significance. The factors were the patient's 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 anaesthetic solution injected, the position of the patient (with hypo- or hyperbaric solutions), the dosage of local

anaesthetic and the volume of anaesthetic solution injected. Recently, Pitkänen and Rosenberg reviewed these factors, and concluded that in clinical practice the spread of subarachnoid local anaesthetics is best controlled by choosing the dose and baricity of the local anaesthetic, and the position of the patient.<sup>5</sup> As mentioned above, the dose of local anaesthetic used influences the spread of local anaesthetics 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.<sup>6</sup> 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 highest levels of sensory blockade, which was between T7 and T1. They concluded that the use of higher doses of local anaesthetics had an advantage of prolonging analgesia at the expense of increasing the incidence of side effects.<sup>7</sup>

Pitkänen and Rosenberg also concluded that patient's position during and immediately after the subarachnoid injection affect the spread of subarachnoid hyperbaric bupivacaine.<sup>5</sup> However; their review was not specifically focused on the parturient population while Russell et al demonstrated that varying positions (Oxford, lateral and sitting) of parturients during the induction of spinal anaesthesia do not affect the spread of subarachnoid hyperbaric bupivacaine.<sup>8</sup> Therefore; the sitting position that was used in the current study for the induction of spinal anaesthesia should not confound the results of the study.

Greene did mention that sites of subarachnoid injection of local anaesthetics above the L2/L3 intervertebral 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.<sup>3</sup> 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 intervertebral spaces were used in comparison to L4/L5.<sup>5</sup> In the current study, two sites of injection were

**Figure 2:** Correlation between length of spinal column and highest level of sensory blockade achieved.



\* T indicates thoracic dermatome

• represents a single parturient

There was also no correlation between weight and highest level of sensory blockade achieved in the term parturient, with  $R = 0.349$ .

used, either the L3/L4 or the L4/L5 intervertebral 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-labelled hyperbaric local anaesthetics move by bulk flow with gravity to dependent areas of the spine.<sup>9</sup> Barker modelled the cadaveric spinal canal using glass tubes and methyl violet blue and demonstrated that hyperbaric local anaesthetic pools in the dependent part of the spinal column, which was T5 or T6.<sup>10</sup> However, Hirabayashi et al, using magnetic resonance imaging, found the lowest point of the thoracic spinal canal to be located at T8.<sup>11</sup> Furthermore, the upper lumbar and lower thoracic spinal canal is inclined eight to twelve degrees to the horizontal when patients are supine.<sup>2</sup> 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 (43.6 cm), 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 anaesthesia, 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 parturients. Both spinal column anatomical limitations and the physics of hyperbaric local anaesthetic 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 demonstrate a correlation between spinal column length and the highest level of sensory blockade achieved.<sup>6</sup> On the other hand, Hartwell et al found a weak ( $R = 0.38$ ) but statistically significant ( $p = 0.006$ ) correlation between spinal column length and the highest level of sensory blockade achieved.<sup>13</sup> 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's spinal column length. However, Hartwell et al's 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.

## Conclusion

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

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