Original Article

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Effect of Hip/Shoulder Width Ratio on the Spread of Spinal Anaesthesia in Term Parturients: A Cross-sectional Study

Anaesthesia Section

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ABSTRACT

Introduction: There is increased cephalad spread of spinal anaesthesia with similar dose of hyperbaric bupivacaine in parturients with greater hip width and shorter shoulder width.

Aim: To determine the effect of Hip and Shoulder width Ratio (HSR) on the spread of spinal anaesthesia in term parturients.

Materials and Methods: The present study was a prospective cross-sectional study conducted in the Department of Anaesthesiology, Regional Institute of Medical Sciences, a tertiary care centre, at Imphal, Manipur, India, from October 2019 to September 2021. A total of 92 parturients aged 18-40 years of age, American Society of Anaesthesiologists (ASA) I and II, undergoing elective caesarean section under subarachnoid block were enrolled. With the parturient in lateral position, a 25G spinal needle was inserted in the L4-L5 interspace. A 2 mL of 0.5% hyperbaric bupivacaine was injected intrathecal in 10 seconds. Age, height, weight, Body Mass Index (BMI), HSR and Vertebral Column Length (VCL) were recorded. Spinal anaesthesia spread was assessed at 0,5,10,15,20,25,30 minutes after the procedure with pin prick test starting from the anaesthetised area and continued cephalad till the sensation changed from the dullness to sharp pain in both the mid-clavicular lines. Statistical analysis of the data obtained was done using Windows based Statistical Package for Social Sciences (SPSS) version 21.0.

Results: The mean age, weight, height and BMI were 28.82±6.2 years, 62.36±5.8 kilograms, 158.63±4 centimetre, and 24.77±2 Kg/m^2, respectively. HSR and shoulder width had a significant correlation with the cephalad spread of spinal anaesthesia with r=-0.672 and p-value <0.001 and r=0.369 and p-value <0.001, respectively.

Conclusion: The HSR and shoulder width has a significant correlation with spread of spinal anaesthesia with a given dose of 0.5% hyperbaric bupivacaine in parturients. The study should expect more cephalad spread of anaesthesia in parturient population when the HSR >1.

Keywords: Cephalad, Correlation, Pin prick, Significant

INTRODUCTION

Spinal anaesthesia is the most preferred and widely used anaesthetic technique for elective Lower Segment Caesarean Section (LSCS). Spinal anaesthesia offers less exposure to the potentially depressant drugs to that of general anaesthesia and also allows early bonding between mother and their newborn as mother is awake throughout the procedure. Despite the numerous advantages, the risk of hypotension following spinal anaesthesia remains the most common side-effect in term parturients even with preloading and left uterine displacement and other protective manoeuvers [1]. This is directly related to the excessive high cephalad spread of spinal anaesthesia. On the other hand, insufficient spinal spread may cause pain and other discomfort in patients and hamper the surgical procedures. Therefore, it is a challenge for the anaesthesiologist to achieve a suitable spread of spinal anaesthesia in caesarean section because of individual anthropometric variations among the parturient [2].

It has been described that approximately 25 factors affect the spread of spinal anaesthesia in the subarachnoid space for a given dose of local anaesthetic drug [3]. But practically it is hard to isolate one factor and quantify its effect on the spread of spinal anaesthesia. Variables that are practically obtainable and that have a predictive value on the spread of spinal anaesthesia will help the anaesthesiologist to predict the spread of spinal anaesthesia. Some of the factors like patient characteristics, techniques of injection, patient posture and baricity of local anaesthetic are the most studied variables that affect the spread of spinal anaesthesia.

The intrathecal spread of spinal anaesthesia for a given dose of plain bupivacaine is highly unpredictable, whereas the spread of spinal anaesthesia with a same dose of hyperbaric bupivacaine is more predictable; so spinal anaesthesia with hyperbaric bupivacaine is the preferred anaesthetic technique for elective LSCS. Some of the patient variables studied which influence the spread of spinal anaesthesia are age, weight, height, gender, patient position, BMI, VCL and abdominal circumference etc., [4]. Since, hormonal and anatomical changes occur during pregnancy, pregnancy itself is one of the factors influencing the spread of spinal anaesthesia. During pregnancy, generally the hip width of the parturient is greater than the shoulder width. Thus, in a horizontal operating table, a pregnant woman lying on the lateral position has slightly head down position due to the difference in the width of the hip and shoulder.

A few workers have studied about this correlation between HSR and the intrathecal spread of spinal anaesthesia with a fixed dose of hyperbaric bupivacaine in both pregnant and non pregnant population of Caucasian ethnicity [5,6]. They opined that HSR may be more important than either patient height or VCL in predicting the cephalad spread of spinal anaesthesia for each parturients. So, the present study was conducted to assess the association/correlation between HSR and spread of spinal anaesthesia in term parturients of ethnic Manipuri population, undergoing elective caesarean delivery between the child bearing age group. The primary outcome of the study was to assess the maximum cephalad dermatome level achieved for a measured HSR and VCL. The secondary measures were to assess the block characteristics, haemodynamic parameters and side-effects such as hypotension, bradycardia, nausea and vomiting.

MATERIALS AND METHODS

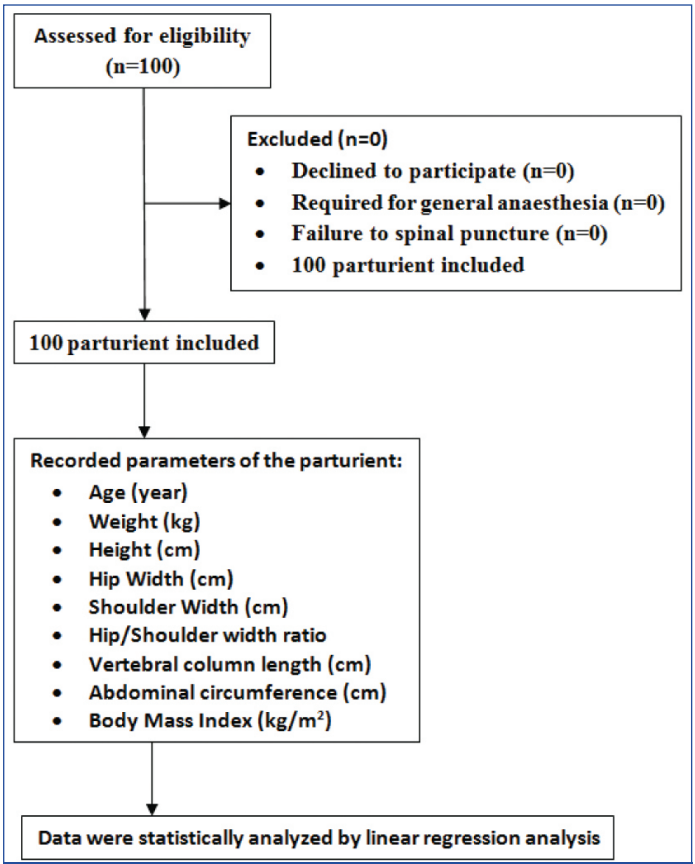
The prospective cross-sectional study was conducted in the Department of Anaesthesiology, Regional Institute of Medical

Sciences, at Imphal, Manipur, India, from October 2019 to September 2021. Approval from the Institutional Research Ethics Board vide order no. A/206/REB-Comm (SP)/RIMS/2015/524/2/2019, dated 24th October 2019 was taken before the commencement of the study.

Inclusion criteria: A total of 92 parturients, belonging to only ethnic population of Manipur with term singleton, ASA physical status I and II were enrolled in the study, after receiving written informed consent.

Exclusion criteria: Parturients refusing regional anaesthesia, history of allergy to study drugs, pregnancy induced hypertension, cardiovascular co-morbidities, central nervous system disease, abnormal coagulation profile, local site infection, spinal deformity and with weight <50 kg or >110 kg, height <140 cm and >180 cm and parturient belonging to other ethnic groups were excluded from this study.

Sampling procedure was of convenience type and flow diagram is shown in [Table/Fig-1].



[Table/Fig-1]: Flow diagram.

Study Procedure

Routine preanaesthetic assessment were conducted for all the patients and inj. Metoclopramide i.v. and inj. Ranitidine 50 mg i.v. were given in the preanaesthetic room with establishment of intravenous line to start the maintenance fluids. On arrival at the operation theatre, monitoring of Heart Rate (HR), Non Invasive Blood Pressure (NIBP), Oxygen Saturation (SPO_2) and Electro-Cardiogram (ECG) was started. Anthropometric measurements were recorded in the sitting position. All the parturient received Ringers Lactate solution (10 mL/kg) as preloading solution within 30 minutes of subarachnoid block. In the lateral position, the skin over the desired site for spinal block was infiltrated with local anaesthetic (2% lignocaine, 1 mL) under strict aseptic and antiseptic precaution and dural puncture was performed in the L3-4 interspace under strict sterile conditions through a 25G Quincke needle using a midline approach. After confirming the free flow of cerebrospinal fluid, spinal anaesthesia was performed with 2 mL (10 mg) of 0.5% hyperbaric bupivacaine with the bevel end turned cephalad without barbotage. The patient was immediately made supine with a left lateral uterine tilt with a wedge. A 22G pinprick was used to assess/detect the cephalad spread of spinal anaesthesia by the loss of sensation to pin prick test at varied time intervals: 0,5,10,15,20,25, 30 minutes after the spinal injection. The pin prick test/assessment was assessed starting from the anaesthetised area and continued cephalad till the sensation changed from the dullness to sharp pain in both the mid-clavicular lines. The number of blocked segments were recorded starting from the sacral vertebra to the maximal cephalad spread. The other block characteristics such as time of sensory block at T10, time to adequate block level (T4-T6), Maximum Sensory Level achieved (MSBL) and Time to Peak Sensory Block level (TPSB) were also recorded. The operative procedure was commenced only when a sensory block of T6 was achieved within eight minutes. A patient was not taken up for the study if adequate block of T6 was not achieved within eight minutes. Rescue measures (10° head down manipulation of the table to attain the desired block level or conversion to general anaesthesia) were advocated. The haemodynamic changes such as the systolic, diastolic and mean blood pressure and Heart Rate (HR) were recorded. The details of any other adverse effects (if any) were also taken into account.

STATISTICAL ANALYSIS

The data were collected in Windows excel worksheet and summarised using descriptive statistics like percentage, mean, etc. Statistical analysis of the data obtained was done using Windows based Statistical Package for Social Sciences (SPSS) version 21.0 (Armonk, NY: IBM Corp) by using the appropriate statistical analysis, Student's t-test for continuous data, Chi-square test for categorical data, $p<0.05$, was considered as statistically significant. The analysis of correlation of HSR, VCL and other anthropometric measurements with the spread of the spinal anaesthesia were analysed using the Pearson and Spearman's Rho correlation tests.

RESULTS

All the parturient included in the study reached a satisfactory spinal anaesthesia dermatome level for caesarean delivery and none required rescue measures. The characteristics of the participants are summarised in [Table/Fig-2]. The maximum cephalad spread of spinal anaesthesia ranged from T6-T2 and the time to reach maximum sensory block was 4.61±1.72 (min).

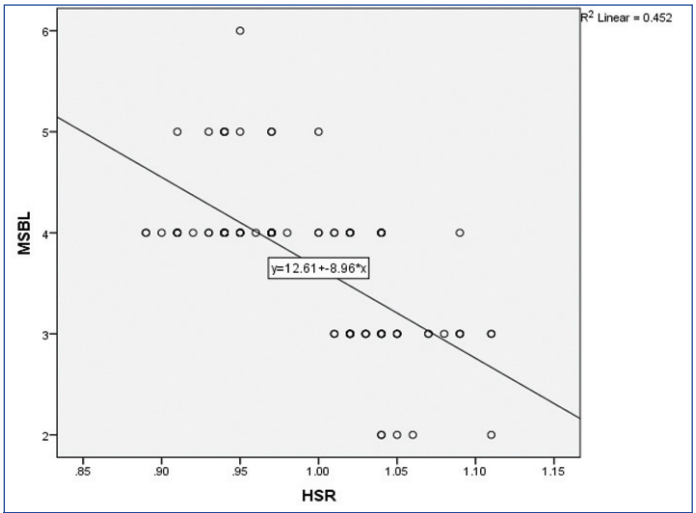
Patient characteristics	Mean±SD*
Age (years)	28.82±6.2
Weight (kg)	62.36±5.8
Height (cm)	158.63±4.0
Hip width (cm)	36.27±2.2
Shoulder width (cm)	36.44±2.5
Hip/Shoulder width ratio	0.99±0.05
Vertebral Column Length (VCL) (cm)	41.71±2.2
Abdominal circumference (cm)	101.68±3.3
Body mass index (kg/m^2)	24.77±2.0

[Table/Fig-2]: Patient characteristics.
*Standard deviation

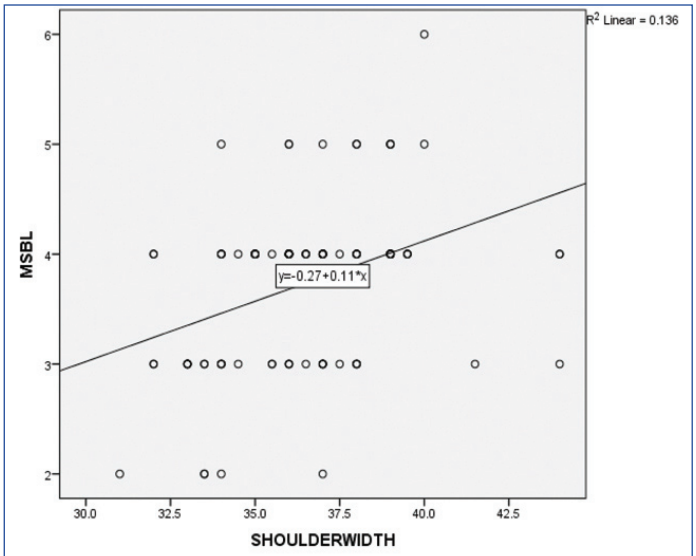
[Table/Fig-3a] summarised Pearson bivariate correlations between parturient characteristics and the cephalad spread of spinal anaesthesia. There was a significant correlation between HSR and cephalad spread of spinal anaesthesia (p-value <0.001; [Table/Fig-3b]) and also between shoulder width and cephalad spread of spinal anaesthesia (p-value <0.001; [Table/Fig-3c]). There was no correlation between parturient age (p=0.968), height (p=0.473), weight (p=0.613), VCL (p=0.357), BMI (p=0.163), abdominal circumference (p=0.881) and the cephalad spread of spinal anaesthesia.

Patient characteristics	r	p-value
Age (years)	-0.004	0.968
Weight (kg)	-0.051	0.613
Height (cm)	-0.073	0.473
Hip width (cm)	-0.181	0.071
Shoulder width (cm)	0.369	<0.001
Hip/Shoulder width ratio	-0.672	<0.001
Vertebral Column Length (VCL) (cm)	-0.093	0.357
Abdominal circumference (cm)	-0.141	0.163
Body mass index (kg/m^2)	-0.015	0.881

[Table/Fig-3a]: Patient characteristics and their correlation with the cephalad spread of spinal anaesthesia.
r: Correlation coefficient; p<0.05 is accepted as statistically significant



[Table/Fig-3b]: Linear correlation analysis of hip/shoulder width ratio and the spread of spinal anaesthesia.
MSBL: Maximum sensory block level



[Table/Fig-3c]: Linear correlation analysis of shoulder width and the spread of anaesthesia.

DISCUSSION

It is well known that various factors could possibly influence the distribution of subarachnoid local anaesthetics [4]. After subarachnoid injection of local anaesthetics, the predictability of the level of spinal anaesthesia is often hard as it is influenced by multiple factors. Pitkänen M and Rosenberg PH pointed out that the dose and baricity of the local anaesthetic along with the position of the patient determine the spread of local anaesthetics [6]. Further, it was shown that patient position and the baricity of the local anaesthetic drugs are the two most important factors influencing caudal or cephalad spread of spinal anaesthesia under the effect of gravitational forces [2-4]. Hence, in the present study, a fixed dose of 2 mL of 5% hyperbaric bupivacaine was used for all the parturients in the left lateral position in order to reduce the confounding factor. On a day-to-day practice, the anthropometric parameters that are easily measurable may aid to predict the level of spinal anaesthesia in parturients.

The study demonstrated that parturient with HSR >1 has a correlation with higher cephalad spread of 0.5% hyperbaric bupivacaine spinal anaesthesia. Normally, during pregnancy, the physiological factors and hormones have significant effects on the bony structure of the pelvis to provide a birth canal for the foetus resulting in an increased hip width compared to that of shoulder width [7]. The spread of intrathecal hyperbaric bupivacaine also depends on the immediate position of the patient [8]. Thus, parturients on a horizontal operating table and in left lateral position with greater hip width and narrow shoulder width assumed a relative Trendelenburg position, resulting in HSR >1, which aided hyperbaric 0.5% hyperbaric bupivacaine to cause more cephalad spread of spinal anaesthesia, immediately after the subarachnoid injection and the increase in HSR >1 may be one of the important patient variables altering the cephalad spread of spinal anaesthesia in pregnant patients undergoing caesarean section as observed in the present study.

It is clearly evident from the current study that almost all the parturients with HSR 1 had sensory block level more than or equal to T4 which resulted in a higher spread of spinal anaesthesia. This finding was in accordance with a few other studies [5,6] which suggested strong positive correlation of cephalad spread with HSR and inverse correlation with height and VCL.

The present study observed a statistically significant correlation between shoulder width of the parturient and the maximum sensory block level. This was not previously mentioned in any studies as a variable influencing the distribution of subarachnoid local anaesthetics. The study did not find any correlation between abdominal circumference and the level of maximum sensory blockade. The studies by Kouk CH et al., and Lee YH et al., failed to find any correlation between abdominal circumference and maximum dermatomal level using 0.5% hyperbaric bupivacaine [9,10]. This lack of correlation could be due to the parturient lying supine; hyperbaric bupivacaine only pooled in the lowest part of the thoracic curvature because the capacity of the upper thoracic pool could not be exceeded by the doses of hyperbaric bupivacaine (10 mg) used in this clinical study.

The current study did not find any correlation between VCL and the spread of spinal anaesthesia in parturients. This was in accordance with other studies [5,11,12]. Pargger H et al., also reported that there was no correlation between VCL and the cephalad spread of spinal anaesthesia, but the drug used for subarachnoid injection was plain bupivacaine and on non parturient [13]. In another study on non pregnant patients, there was no correlation with VCL and the spread of spinal anaesthesia [14]. However, Hartwell BL et al., found strong correlation of cephalad spread and VCL in term parturient when employing fixed dose of hyperbaric bupivacaine [15]. The results of the present study and those of Hartwell BL are different and this may be due to the technical differences of spinal anaesthesia administration, avoidance of barbotage, different level and doses of intrathecal placement [15].

The current study found a statistically significant positive correlation between height and VCL. This finding is on contrary with that of Hartwell BL et al., who reported a weak correlation between height and VCL [15]. Racial differences causing the differences in anthropometric measures and usually shorter height of Asian than European women may explain the differences [16].

In the present study, no correlation between the cephalad spread of spinal anaesthesia and age, weight, height and BMI in pregnant patients was observed and this is similar to other studies conducted by Norris MC and Hartwell BL et al., [11,15].

Limitation(s)

The present study did not consider the effect of gravida which may alter the spread of spinal anaesthesia. Further studies can be carried out in non parturients to find out the outcome.

CONCLUSION(S)

The HSR and shoulder width has a significant correlation with spread of spinal anaesthesia with a given dose of 0.5% hyperbaric bupivacaine in parturients. The measurements obtained from the parturient hip and shoulder will help the anaesthesiologists to predict the spread of spinal anaesthesia and to titrate the dose of intrathecal 0.5% hyperbaric bupivacaine for individual parturient. It should expect more cephalad spread of anaesthesia in parturient population when the HSR >1.

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