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The Effect of Hip Shoulder Width Ratio and Vertebral Column Length on The Spread of Spinal Anaesthesia in Term Parturient in Elective Caesarean Section: A Prospective Study

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ABSTRACT
The aim of the study is to determine the effect of age, height, weight, BMI, hip /shoulder width ratio and vertebral column length on the spread of spinal anaesthesia in term parturient. In pregnant patients, more cephalad spread of spinal anaesthesia is observed with a fixed dose of hyperbaric Bupivacaine who have larger hip width and relative narrow shoulder width. Hence, we hypothesized that increased cephalad spread of spinal anaesthesia maybe correlated with increase in hip /shoulder width ratio and vertebral column length recorded for 63 term parturients. Spinal anesthesia was performed using strict aseptic precautions through L3-L4 space by injecting 0.5% bupivacaine 3mL (depending on patient's height). Pearson and Superman's Rho correlation tests were used for the analysis of correlation between patient characteristics and separate spread of spinal anaesthesia. There was a significant correlation between hip/shoulder width ratio and cephalad spread of spinal anesthesia (P=0.009). Other patient characteristics has no correlation between cephalad spread of spinal Anesthesia (P=0.05). Vertebral column length had correlation with height of the patient. There is a strong correlation between the cephalad spread of spinal anesthesia and hips/shoulder width ratio in term parturients. Vertebral column length has no correlation with spinal anesthesia. There was no correlation between patient's height, vertebral column length, age, BMI in predicting cephalad spread of spinal anesthesia.

INTRODUCTION

Spinal anaesthesia is a safe, simple, rapid, effective and easy to apply anaesthetic technique for elective caesarean section. Despite the advantages of spinal anaesthesia, hypotension is a common complication with an incidence of 70%-85% in parturients. Many factors including the characteristic of injected solution, patient position, height, weight, pregnancy, intra-abdominal pressure, lumbosacral cerebrospinal fluid volume determines the intrathecal spread of local anaesthetics. In obstetrics physiological changes due to pregnancy including changes in spinal curvature, venous pooling secondary to progesterone induced decrease in vascular tone and aortocaval compression by the gravity uterus contribute to hypotension during Caesarean section under regional anaesthesia.

Widening of the hips automatically and pubic symphysis laxation under the influence of gestational hormones to prepare the birth canal for birth is nature for pregnancy at term.

Considering this fact, we hypothesized that the increased hip shoulder width ratio (HSR) may play a vital role in the cephalad spread of spinal anaesthesia which is a practically measurable patient variable to predict the spread of spinal anaesthesia in Term parturient. Other data such as patient's age, height, weight, body mass index (BMI) and vertebral column length (CVL) to determine that effect on the separate spread of spinal anaesthesia.

Review of Literature: Mehmet Canturk *et al* (2018) conducted a prospective observational study on hip/shoulder width ratio alters the spread of spinal anesthesia among 58 parturients and demonstrated a significant correlation between hip/shoulder width ratio and the level of sensory block after spinal anesthesia[1].

Ting-ting Ni *et al* (2018) conducted an observational study on intra-abdominal pressure, vertebral column length and spread of spinal anesthesia in parturients undergoing cesarean section among 113 parturients undergoing cesarean section and concluded that intra-abdominal pressure and vertebral column length were significant predictors of intrathecal spread of plain bupivacaine[2].

Xiangdi Yu *et al* (2016) conducted a study the effect of parturient height on the median effective dose of intrathecally administered ropivacaine among 150 parturients and concluded that ED50 of intrathecal ropivacaine using sensitivity to cold sensation increased with parturient height, indicating that dose may be determined in part by height[3].

R. Ousley *et al* (2012) conducted a study on assessment of block height for satisfactory spinal anaesthesia for caesarean section among 94 term parturients and concluded that cold and pinprick testing of block height correlate well with touch and can provide useful information during the assessment of adequacy of spinal anaesthesia for caesarean section[4]. (p<0.0001).

Fig. 1: The anatomical measurement landmarks. Demonstrating the landmarks for the anthropometric measures. a: acromion process, b: distance from acromion process to midline, c: distance from iliac crest to midline, d: wing of scapula, C7: Spinous process of C7 vertebra, IC: iliac crest, SH: sacral hiatus

MATERIALS AND METHODS

This study was conducted at Sri Siddhartha Medical College Hospital and Research Center, Tumkur. CONSORT guidelines were followed in this study[5]. Computer based randomization was done. After written informed consent, thirty-five parturients between 18 and 40 years of age of ASA Class I and II, scheduled for elective caesarean sections were enrolled in the study. Investigator and the patient were blinded to the study. A third member of the department was employed to prepare the solutions to be used in the study. Infection at the site of spinal anaesthesia, patients with uncontrolled hypertension and diabetes, any neurological or psychiatric diseases and patients with bleeding or coagulation disorders were excluded from the study.

The following formula was employed to arrive at the sample size.

n=2x (Za + Z 1-ß)2 s 2 /(d)2.

Za=standard table value for 95% CI=1.96.

Z 1-ß=Standard table value for 80% Power=0.84

s=standard deviation (1.6)

d=minimum expected difference b/w means of 2 groups (0.8)

n=Sample size.

n=20.0704 / (0.8)2.

n= 1.36.

considering dropout rate, final sample size n = 35.

Inclusion Criteria:

- Age: 18-40years.
- Parturients with uncomplicated, singleton and term pregnancy.
- Patient willing to give informed written consent.

- Patients belonging to ASA Grade I and Grade II.
- Patients undergoing elective cesarean section under spinal anaesthesia.

Exclusion Criteria:

- Patients not willing to give informed consent.
- Contraindication to spinal anaesthesia, allergic reaction to local anaesthetic.
- Parturients with preeclampsia, diabetes mellitus, cardiac diseases.
- Gestational age <37 weeks , multiple gestation.
- Morbid obesity (BMI>35), height <150cm or >175 cm.
- Placental and fetal abnormalities, polyhydramnios or oligohydramnios.

After obtaining approval and clearance from the institutional ethics committee, the patients fulfilling the inclusion criteria will be enrolled for the study after obtaining informed consent.

All study participants were informed about the purpose of the study and the method used to measure the level of sensory blockade prior to anesthesia. A large bore 18G intravenous line was secured on the dorsum of left hand and 500ml of Ringer's lactate solution was infused 30 minutes before the patient's transfer to operating room. When the parturient arrives at the operating room, in sitting position on operating table, hip width was measured between two iliac crests, and shoulder width was measured between two acromion processes. Vertebral column length was measured from C7 prominence to sacral hiatus (C7-SH) and to iliac crest (C7-IC). Standard monitors were installed, including an automated noninvasive blood pressure device, a pulse oximetry monitor and an electrocardiography monitor. Baseline blood pressure and heart rate were recorded. Later parturient was turned to the right lateral decubitus position on a horizontal operating table for spinal anesthesia. Under strict aseptic precautions spinal anesthesia was performed using the median approach through the L3 -L4 intervertebral space. A Quincke 27gauge spinal needle was inserted with its bevel oriented parallel to the dural fibers and then rotated to direct the bevel cephalad. Then, 0.5% hyperbaric bupivacaine was injected into the subarachnoid space. After the spinal injection, the patients were immediately returned to the supine position. A left uterine displacement of about 15 degrees was maintained by inserting a folded blanket placed under the patient's right hip. No attempt was made to influence the level of sensory blockade by manipulating the operating table.

A proforma was used to collect the data which included patient details, diagnosis, surgery proposed, anaesthesia details etc. The blood pressure was measured at 1-minute intervals for 5 minutes and then at 2-minute intervals for 10 minutes after the spinal injection. Hypotension is defined as a drop in systolic blood pressure to below 100 mmHg, or a decrease of more than 30% in the baseline mean arterial blood pressure (MAP). Intravenous ephedrine (6 mg) was administered when hypotension was noted. Heart rate less than 50/min was treated with IV bolus 0.6 mg atropine.

Level of cold sensation loss was checked by using an ice cube at 1 minute, 5 minutes, 10 minutes, 15 minutes and 20 minutes spinal anesthesia. The level of sensory blockade at 20 minutes after spinal injection was defined as the level of maximum sensory blockade. Loss of cold sensation was assessed by asking the patient to report when the cold stimulus appears similar to a reference point (forehead skin). The dermatomal level below the detected stimulus was recorded as the level of sensory blockade[6]. The doses of ephedrine given and the incidence of nausea and vomiting during 15 minutes after spinal anesthesia was recorded. Nausea and vomiting were treated with injection ondansetron 4mg IV.

Statistical Analysis: The statistical package program SPSS 21.0 was used as the main statistical analysis tools in this study. Minimum sample size (n) was calculated to be 35 at a probability level (a)=0.05 and effect size (p)=0.37 for a statistical power level (1-ß)=0.84. Normal distribution of data was analyzed by using descriptive analysis which is obtained in the Table 1 showed the minimum and maximum values of mean and standard deviation obtained from the values.

Table 1:Patient Characteristics

Parameter	N	Minimum	Maximum	Mean	SD
Age	35	18.0	32.00	24.7143	3.36567
Height	35	150.00	173.00	161.2286	6.74792
Weight	35	55.00	80.00	66.4571	7.488073
BMI	35	22.70	36.60	25.8086	2.84248
HIP Width	35	61.00	84.00	71.7429	5.02548
Shoulder Width	35	30.00	45.00	38.6000	3.40588
HIP Shoulder ratio	35	1.65	2.40	1.8681	0.16581
Vertebral column length C7	35	44.00	58.00	51.3143	3.13211
Vertebral column C7	35	31.00	48.00	40.9714	4.21821
Valid N (list wise)	35				

In this phase, reliability analysis has been applied to the data obtained from 5 items. As a result of the analysis, the Cronbach's Alpha score has been found out as 0.726 for all items on the scale indicate that the scale is quite reliable.

Repeated measures of ANOVA was used to measure the quantitative data which was been analyzed by using Friedman test. By obtaining Kendal coefficient of concordance as 0.976. If a statistical significance was detected, Tukey HSD test was used to determine which parameter was responsible for the difference.

Table 2: The Patient Characteristics and their Correlation with the Cephalad Spread of Spinal Anesthesia

Patient characteristics	Sig(2tailed)	Correlation coefficient
Age	0.10	0.373
Height	0.005	0.351
Weight	0.003	0.380
BMI	0.099	0.205
HIP Width	0.874	0.205
Shoulder Width	0.270	0.141
HIP Shoulder ratio	0.344	0.117
Vertebral column length C7	0.018	0.302
Vertebral column C7	0.395	0.107
Valid N (list wise)		

The correlation between the cephalad spread of spinal anesthesia and age, height, weight, BMI, HSR and VCL (C7-SH and C7-IC) were analyzed with Pearson and Sperman's Rho Correlation Tests. A p value <0.05 was considered statistically significant.

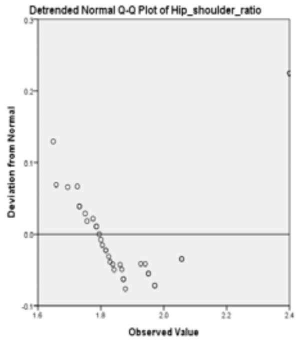

Fig 2: The correlation between hip/shoulder width ratio and the spread of spinal anesthesia. Demonstrates the significant correlation between the spread of spinal anesthesia and hip/shoulder width ratio (P=0.117).

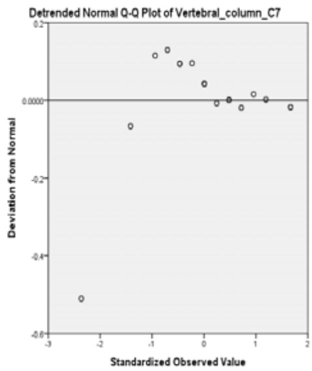

Fig. 3: The correlation between vertebral column length (C7-SH) and patient height. Demonstrates the correlation between the height of the patient and vertebral column length (in the figure C7 – SH represents the distance between the process of C7 vertebra to the sacral hiatus) (P=0.107).

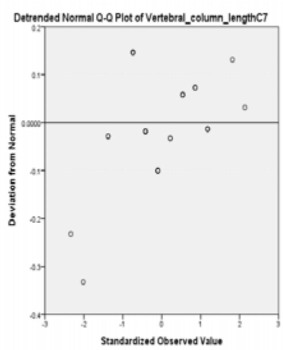

Fig. 4: The correlation between vertebral column length (C7-IC) and patient height. Demonstrates the correlation between the height of the patient and vertebral column length (in the figure C7-IC represents the distance be- tween the process of C7 vertebra to iliac crest) (P=0.302).

RESULTS AND DISCUSSIONS

Time to reach maximum sensory block was 14.3±1.2 minutes and the maximum cephalad spread of spinal anesthesia ranged from T4 to T2. Table 2 summarizes the relationship between patient characteristics and the cephalad spread of spinal anesthesia. Inj. Atropine was administered to (2%) and ephedrine to 10 (3.5%) of the parturients. There was no correlation between patient age (P=0.36), height (P=0.35), weight (P=0.38), BMI (P=0.205) and the anesthesia spread. There was a significant correlation between HSR and cephalad spread of spinal anesthesia (P=0.009., Figure 1). VCL (C7-SH and C7-IC) did not have a correlation with the cephalad spread of spinal anesthesia (P=0.305., P=0.107) but had a statistically significant correlation with the height of the patient (P=0.032., P=0.019) (Figures 2 and 3).

Although cephalad spread of spinal anesthesia is multifactorial and is hard to predict the level of spinal anesthesia, the parameters that are easily measurable may aid to predict the anesthesia spread at the daily practice[7]. Patient position and the baracity of the local anesthetic drugs are the two factors influencing caudal or cephalad spread of spinal anesthesia under the effect of gravitational forces. We found a positive correlation between HSR and the cephalad spread of spinal anesthesia with a given dose of hyperbaric bupivacaine in term parturient. Physiological factors and hormones during pregnancy effect on the bony structure of the pelvis to provide a birth canal for the fetus resulting in an increased hip size[8]. Since the trunk gains a relative Trendelenburg position on the horizontal operating table due to a wider hip, the increased HSR may result in spilling of the hyperbaric local anesthetic solution more cephalad leading to an increased spread of spinal anesthesia[9].

To our knowledge, there was no prospectively designed study documenting the effect of HSR on the spread of spinal anesthesia in the literature. The increased HSR may be one of the important patient variables altering the cephalad spread of spinal anesthesia in pregnant patients undergoing cesarean section observed in the current study.

Few studies showed correlation with VCL and spread of spinal Anesthesia whereas few showed no correlation between the above said parameters.

We found no correlation between cephalad spread of spinal Anesthesia and age, weight, height, BMI as reported by other studies[10].

In conclusion, of the patient characteristics studied., age, weight, height, BMI and VCL have no correlation with the cephalad spread of spinal anesthesia with a fixed dose of hyperbaric bupivacaine in term parturient. HSR has a significant correlation with the spread of spinal anesthesia. In pregnant patient population, more cephalad spread of anesthesia may be expected with increasing HSR which may be more valuable than VCL for predicting cephalad spread of spinal anesthesia.

Disclosure of Conflict of Interest: None.

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