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Original Research Article

The effect of hip shoulder width ratio and vertebral column length on sensory level in term participants posted for lower segment caesarean section under spinal anaesthesia in Indian population: A prospective observational study

Kiran Kishor Pisekar[1]*, Vaibhao Dongre[2], Sherin Rasalam[3], Supriya Chakravarthy[4], Pratik Shah[1]

[1] *Dept. of Cardiac Anesthesia, U.N.Mehta Institute of Cardiology and Research Center, Ahmadabad, Gujarat, India*
[2] *Dr. L H Hiranandini Hospital, Mumbai, Maharashtra, India*
[3] *Max Superspeciality Hospital, New Delhi, India*
[4] *MIOT Hospital, Chennai, Tamil Nadu, India*

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ABSTRACT

Background: Hypotension is the most common complication of spinal anesthesia with high intrathecal spread of local anaesthetic drug especially during caesarean section. Hip Shoulder width Ratio (HSWR) is one of the factors which affects spread of spinal anaesthesia.

Materials and Methods: 85 ASA II participants with singleton term pregnancy undergoing elective caesarean section received 12mg hyperbaric bupivacaine intrathecally with 26G Quincke's spinal needle in L3-4 intervertebral subarachnoid space via midline approach. Post spinal anaesthesia haemodynamic parameters were monitored every 5 minutes for the first 20 minutes and at the end of surgery. Sensory level was assessed by a pinprick test every 5 minutes till 20 minutes and post-surgery. Hypotension was defined as 20% fall from baseline systolic blood pressure at 15 minutes post spinal anaesthesia.

Result: We found significant positive correlation between high shoulder width ratio and highest sensory level achieved (p - 0.0005) using mutiple regression analysis and pearson's correlataion. With every unit increased in high shoulder width ratio spinal level significantly increased by 5 units. Hip shoulder width ration and age were significantly correlatwd with incidence of hypotension.

Conclusion: Hip-shoulder Width Ratio has a positive effect on cephalad spread of spinal anaesthesia and thus incidence of hypotension. By knowing the Hip-shoulder Width Ratio, it can help anaesthesiologists to predict the spread of spinal anaesthesia and titrate the dose of 0.5% hyperbaric bupivacaine.

1. Introduction

Caesarean deliveries are routinely performed under spinal anaesthesia unless contraindicated, and considered as the gold standard. Advantages include avoidance of general anaesthesia and the airway management concerns that accompany general anaesthesia with additional benefits of reducing the metabolic stress response to surgery and early maternal fetal bonding. It also has few complications, the most common and severe being hypotension (7.4 – 74%)[1] which is associated with high intrathecal spread of local anaesthetic drugs. In pregnancy there is narrowing of lumbosacral space due to the compression of inferior vena cava by hypertrophic uterus which develops plexus venosus collateral circulation in the epidural space leading to reduction in cerebrospinal fluid volume. Thus, hypotension is directly correlated to higher cephalad spread

* *Corresponding author*.
E-mail address: kiranpisekar@gmail.com (K. K. Pisekar).

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of spinal anaesthesia.[2] Higher spread of local anaesthetic intrathecally leads to increased sympathetic nervous system blockade causing increased venous capacitance and thus leading to hypotension. Untreated severe hypotension can pose severe risks to both mother and the baby.

Measures taken to prevent hypotension currently are left lateral displacement of the uterus in supine position to prevent vena-caval compression, infusion of intravenous fluids, and use of vasopressors like ephedrine, adjusting or reducing the dose of spinal anaesthetic drug.

The spread of local anaesthetics in the subarachnoid space for a given dose of a local anaesthetic drug is affected by many factors. Patient variables, technique of injection, baricity of the local anaesthetic agent and the posture of the patient are the most studied variables to affect the spread of spinal anaesthesia. Anthropometric parameters like weight, height, body mass index, vertebral column length (VCL) have been found to be associated with intrathecal spread of the drug.

Hormonal changes during pregnancy causes anatomical widening of the hips due to fat deposition and laxation of symphysis pubis to prepare the birth canal. It has been hypothesised that increase in hip width as compared to shoulder width causes higher spread of spinal anaesthetic drugs.

2. Materials and Methods

It was a prospective observational study conducted after approval by the hospital ethics and scientific committee over a period from November 2018 to June 2020. After obtaining written informed consent we enrolled parturient for elective caesarean section conducted at our institute.

Pre-anaesthetic assessment was carried out with detailed history, general, physical and systemic examination including airway assessment. Patient's informed consent was taken after explaining spinal anaesthesia in detail. All the routine laboratory investigations were done.

Preoperatively before shifting to operating room, 20-gauge intravenous (IV) catheter was inserted and 10 ml/kg/hr ringer's lactate crystalloid solution was infused. After attaching standard monitors i.e. electrocardiography, non-invasive blood pressure, oxygen saturation (SpO2), baseline values of pulse, systolic and diastolic pressure, SPO2 was recorded. Patients were oxygenated with nasal prongs at 2 litres/min. Patients were positioned on the operation table and the procedure was explained.

Anthropometric measurements were taken using standard medical measuring tape as follows. Hip width (in cm) – distance between highest point of either side of iliac crest. Shoulder width (in cm) – distance between two acromion processes. Vertebral column length (in cm) – distance between C7 spinous process and sacral hiatus. Hip shoulder width Ratio was calculated by dividing hip width with shoulder width. After all the measurements, under all aseptic precautions, painting was done with 10% w/v betadine solution followed by 2% chlorhexidine, drape was applied. L3-L4 interspace was located by drawing a line in between the highest point of the iliac crest after palpating on either side of the hip. After infiltrating 3 ml of local anaesthetic solution (2% lignocaine) into the skin and subcutaneous tissue, 12 mg of 0.5% hyperbaric bupivacaine was injected intrathecally without barbotage with 26 G Quincke's spinal needle after confirming free flow of clear CSF. After intrathecal injection, the patient was made to lay down in supine position with left lateral tilt of the uterus (with the help of wedge underneath the buttocks) on the operation table in horizontal position throughout the surgery. Pinprick test was done using 26 G needle to detect cephalad spread of spinal anaesthesia at 0 mins, 5 mins, 10 mins, 15mins, 20 mins after intrathecal injection. Pinprick was started from 5th sacral dermatomal level upwards and the patient was asked for any change in sensation from dullness to sharp pain till maximum cephalad spread. Skin incision was taken once the sensory blockade reached 6th thoracic dermatomal level. Hypotension was defined as a fall in systolic blood pressure of >20% from the baseline values and it was treated with adequate doses of ephedrine and fluid boluses of Ringer's lactate solution. 5 units of oxytocin was given slowly after the delivery of the baby. At the end of surgery, sensory level was checked using a pinprick test and looked for any regression in level of anaesthesia.

All patients were observed in the Post anaesthesia care unit for 1 hour after the end of surgery.

The following parameters were monitored after spinal anaesthesia.

1. Haemodynamic parameters: Heart rate, non-invasive blood pressure monitoring every 3 minutes till 20 minutes, then every 5 minutes.
2. The highest Level of sensory block by pinprick test every 5 minutes till 20 mins and post-surgery.

2.1. *Inclusion criteria*

ASA grade I and II female term parturient posted for elective lower segment caesarean section under spinal anaesthesia in 18 – 45 years' age group.

2.2. *Exclusion criteria*

ASA grade > II, age below 18 and above 45 years, Patients with PIH/ eclampsia, placenta previa, abruptio placentae, uterine myomas, oligo and polyhydramnios, Multiple pregnancy, malpresentation, need for conversion of spinal anaesthesia to general anaesthesia, contraindication to regional anaesthesia, Patient allergic to any study drug.

2.3. Sample size calculation

Formula for the sample size (n):

$n = [(Z\alpha + Z\beta) / C]^2 + 3$

Where,

$Z\alpha$ = the critical value of the Normal distribution at $\alpha/2$ (for a confidence level of 95%) = 1.96,

$Z\beta$ = the critical value of the Normal distribution at β (for a power of 80%) = 0.84,

C = 0.5 * ln[(1+r)/(1-r)],

By taking r = 0.30....... (“r” is the hypothesised or anticipated correlation coefficient),

C= 0.5 * ln [(1+0.30)/ (1-0.30)] = 0.5 * ln [1.30/0.70] = 0.5 * ln [1.86] = 0.5 * 0.62= 0.31

By inserting above values in given sample size formula,

$n = [(1.96 + 0.84) / 0.31]^2 + 3$, $n = [(2.80) / 0.31]^2 + 3$, $n = [9.03]^2 + 3$, n = 81.5 + 3, n = 84.5, n ≈ 85

Sample size (n) = 85

2.4. Statistical analysis

The collected data were analysed with IBM.SPSS statistics software 23.0 Version. To describe about the data descriptive statistics, mean & S.D were used. To find the significant difference in the multivariate analysis for repeated measures the repeated measures of ANOVA was used with Bonferroni correction to control the type I error on multiple comparisons. To assess the relationship between the variables Spearman’s rank correlation was used. In all the above statistical tools the probability value 0.05 is considered a significant level.

3. Result

85 participants were included in the study. 53 participants had hypotension. Mean age was 32 ± 3 years in hypotensive participants. Mean age was 31 ± 3 years in non-hypotensive participants. Mean BMI was 22.57 ± 3.13 kg/m2 in hypotensive participants. Mean BMI was 23.63 ± 2.74 kg/m2 in non-hypotensive participants. Mean HSW Ratio was 1.24 ± 0.10 in hypotensive participants. Mean HSW Ratio was 1.18 ± 0.06 in non-hypotensive participants. Mean VCL was 53.5 ± 5.7 cm in hypotensive participants. Mean VCL was 53.5 ± 2.9 cm in non-hypotensive participants. (Table 1)

Table 1: Demographic variables

	Hypotension Present	Hypotension Absent	p-value
Age	32 ± 3	31 ± 3	0.0150
Height	157.90 ± 7.13	157.89 ± 6.74	0.9950
Weight	71.70 ± 10.37	74.63 ± 9.15	0.1830
BMI	22.57 ± 3.13	23.63 ± 2.74	0.1090
HSWR	1.24 ± 0.10	1.18 ± 0.06	<0.0001
VCL	53.5 ± 5.7	53.5 ± 2.9	0.9560

Out of 85 parturient, 7 parturient achieved T3 level and all 7 had hypotension (100%), 21 parturient achieved T4 level out of which 18 had hypotension (85.7%), 22 parturient achieved T5 level out of which 22 had hypotension (61.18%), 34 parturient achieved T6 level out of which 13 had hypotension (54.16%).

Multiple linear regression analysis showed significant positive correlation between HSW ratio and sensory level, whereas no correlation was found between VCL, age, height, BMI and sensory level. (Table 2)

Sensory level = 3.076 + 0.022 (Height) -0.104 (Weight) + 0.334 (BMI) + 5.212 (Hip-shoulder width ratio) +0.002 (Vertebral column length). With every unit increased in high shoulder width ratio spinal level significantly increased by 5 units.

Pearson’s correlation showed significant positive correlation between HSW ratio and sensory level (p - 0.0005), there was no correlation between VCL and sensory level Unpaired t-test between patient variables and incidence of hypotension showed statistically significant positive correlation between Age, HSW Ratio and incidence of hypotension (p- 0.015) and (p - 0.001) respectively.

No correlation was found between height, weight BMI, VCL and incidence of hypotension.

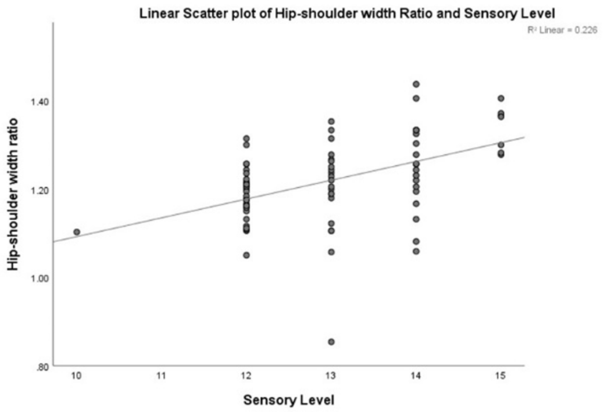

Figure 1: Linear scatter plot of hip shoulder width ratio and highest sensory level

4. Discussion

The anatomical and physiological changes in pregnancy are due to the changes in hormonal activity, increased maternal metabolic demands and biochemical alterations induced by the fetoplacental unit and mechanical effects of growing uterus. In the supine position, aortocaval compression is evident at term leading to supine hypotensive syndrome. One of the major worrisome complications in caesarean section post spinal anaesthesia is high incidence of hypotension.

Table 2: Multiple linear regression analysis between patient variables and highest sensory level achieved

Variable	Unstandardized Coefficient	Standard Error	Standardised Coefficient	t	p-value	95% CI
Height	0.022	0.037	0.138	0.581	0.564	(-0.06,0.1)
Weight	-0.104	0.089	-0.955	-1.175	0.244	(-0.29,0.08)
BMI	0.334	0.277	0.925	1.209	0.231	(-0.22,0.89)
Hip-shoulder width ratio	5.212	1.11	0.467	4.697	0.001	(3.01,7.43)
Vertebral column length	0.002	0.023	0.008	0.069	0.946	(-0.05,0.05)

Table 3: Pearson correlation between patient variable and highest sensory level

	Correlation coefficient (r)	p-value
Height	-0.1330	0.2290
Weight	0.0320	0.7740
BMI	0.0890	0.4220
HSWR	0.4750	<0.0001
VCL	-0.0580	0.6020
Systolic BP Difference (%)	-0.5460	<0.0001

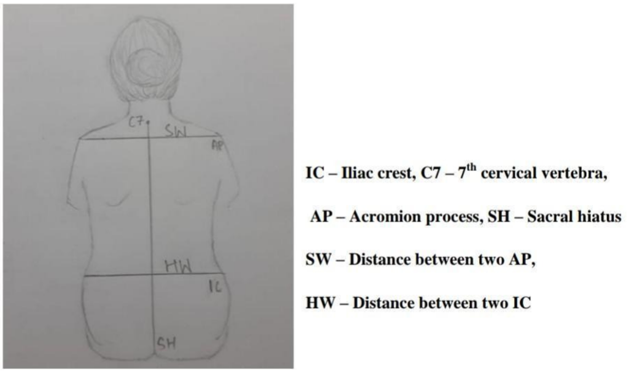

Figure 2: Anthropometric measurements and position for spinal anaesthesia

Since fluid status of the body is one of the determinants of hypotension, we preloaded all participants with lactated Ringer solution, even though controversies exist about the concept of preloading.[3–5]

In our study, hypotension was defined as a fall in SBP >20% from pre-spinal (baseline) value in the first 20 minutes post spinal anaesthesia. Cantürk M, Cantürk FK et al[6] considered hypotension as a fall in 20% systolic blood pressure below baseline. ShiQin X et al[7] defined hypotension as a fall in systolic blood pressure of more than 20% from baseline value. Incidence of hypotension were considered only till 20 minutes after induction, to eliminate surgery-related causes for hypotension.

Hartmann B et al[8] studied the risk factors for hypotension and suggested sensory level as a predictor of hypotension. Singla D, Kathuria S et al[9] suggested that sensory level blockade ≥ T6 is a risk factor for hypotension. Fakherpour A, et al[10] suggested that sensory level T4 and above was a risk factor for hypotension. Chumpathong S et al[11] studied the risk factors for hypotension in caesarean section and suggested that a sensory level ≥T5 as a risk factor for hypotension. Carpenter et al[12] found higher sensory levels as independent risk factor development of hypotension. In their study sensory level above T5 was found to increase incidence of hypotension, sensory level above T4 lost the vasoconstrictor mechanism in the upper extremities which could moderate the fall in blood pressure. In our study there was a high incidence of hypotension with increased sensory level. We found a positive correlation between the highest sensory level achieved and incidence of hypotension similar to the above mentioned study. With level of spinal anaesthesia exceeding T4, circulatory regulation could be affected by a blockade of the sympathetic nervous system with resulting reductions in both venous return and systemic vascular resistance, cardio-acceleratory fibres blocked could lead to a decrease in heart rate and cardiac output. We found that an increase in the level of sensory block significantly increases the incidence of hypotension. Cantürk M et al[6] found hip /shoulder width ratio to be positively correlated with incidence of hypotension and sensory level but there was no relation between vertebral column length and sensory level achieved.

In our study we have found a positive correlation between HSWR and incidence of hypotension. Zhou QH et al[13] did a study on abdominal Girth, vertebral Column Length, and spread of spinal anaesthesia, but there was no relation between VCL and sensory level achieved. Chanimov M et al[14] in their study found a significant correlation between vertebral column length (C7 to iliac crest) and highest sensory level. Rahiza WW et al[15] in a study of the relationship between spinal column length and sensory spread, spinal column length (C7 to SH) showed no correlation with the highest level of sensory blockade achieved. We have found a positive correlation between HSWR and highest sensory level achieved, whereas VCL, height, weight, BMI had no effect on sensory level. It has been hypothesised that increase in hip width as compared to shoulder width causes more cephalad spread of local anaesthetic due to the relative trendelenburg position gained by the trunk on horizontal operating table due to wider hip. The physiological factors and hormones during pregnancy affect the bony structures of the pelvis to provide a wider birth canal for delivery of baby leading to increase in hip width.

5. Conclusion

Hypotension is the most common complication during caesarean section under spinal anaesthesia. Higher sensory level causes hypotension which indeed is affected by various factors. We have found that Hip-shoulder Width Ratio has a positive effect on higher spread of spinal anaesthesia and thus incidence of hypotension. By knowing the Hip-shoulder Width Ratio, it can help anaesthesiologists to predict the sensory level and titrate the dose of 0.5% hyperbaric bupivacaine. Higher sensory level above T5 can be expected with Hip-Shoulder Width Ratio more than 1.24.

6. Source of Funding

None.

7. Conflict of Interest

None.

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Author biography

Kiran Kishor Pisekar, Resident

Vaibhao Dongre, Consultant Anesthesiologist

Sherin Rasalam, Consultant Transplant Anesthesiologist

Supriya Chakravarthy, Senior Resident

Pratik Shah, Research Fellow

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