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A STUDY TO ASSESS THE BASELINE PULSE OXIMETER PERFUSION INDEX AS A PREDICTOR OF INTRAOPERATIVE HYPOTENSION IN PARTURIENTS UNDERGOING SPINAL ANAESTHESIA FOR CAESAREAN SECTION

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Abstract

Introduction: Hypotension following Spinal Anaesthesia (SA) in Lower Segment Caesarean Section (LSCS) can be deleterious to the parturient and to the fetus. Perfusion index (PI) is the ratio of pulsatile blood flow to non-pulsatile blood flow in the peripheral vascular tissue which can be measured using a pulse oximeter based on the amount of infrared light absorbed. PI can assess perfusion dynamics and detect the likelihood of development of hypotension following SA. Hence, pulse-oximeter derived PI can be used as a non-invasive means to predict intra-operative hypotension and take adequate measures to prevent it.

Aims & Objectives: To evaluate baseline perfusion index of greater than 3.5 (>3.5) as a predictor of intraoperative hypotension following spinal anaesthesia in lower segment caesarean section.

Methodology: Sixty American Society of Anaesthesiologists Physical status (ASA-PS) class II parturients undergoing elective LSCS under SA were selected for a prospective comparative study after approval from Institutional Ethical Committee and informed consent. Baseline hemodynamic values including PI were recorded in supine position with wedge under right buttock to prevent aorto-caval compression. Parturients were divided into two groups.

Parturients with baseline PI <3.5 were assigned to Group1 and those with PI ≥3.5 to Group2. A fall in >20% of systolic blood pressure (SBP) or SBP <90 mmHg after SA was treated with IV bolus Inj.ephedrine (6mg). The number of incidences of hypotension and doses of ephedrine required were recorded in both groups for 60 minutes following SA.

Results: The demographic parameters were statistically similar in both the groups. Our study showed statistically significant increase in the incidence of hypotension and higher use of intravenous ephedrine 6 mg bolus doses in Group 2 (PI ≥3.5) compared to Group 1 (PI<3.5) after SA. There were 30 parturients in each group. 24 parturients in Group 2 developed hypotension compared to 8 parturients in Group 1 with Mean Total Amount of Ephedrine used in Group 1 being 2.4 ± 4.34 mg and in Group 2 being 12.6 ± 8.54 mg (p = < 0.001). We also found out a new cut-off PI of 3.8. There was no statistically significant difference in APGAR score between the two groups.

Conclusion: Higher baseline PI is associated with higher incidence of hypotension following SA in parturients undergoing LSCS. Hence, PI can be used as a tool in predicting intraoperative hypotension in parturients undergoing elective LSCS and help in preventing it.

Key words: Perfusion Index, Caesarean Section, Post Spinal Hypotension

INTRODUCTION

American Society of Anaesthesiologists Task Force on Obstetric Anaesthesia in their guidelines have mentioned to consider neuraxial techniques in preference to general anaesthesia (GA) for most lower segment caesarean section (LSCS)[1]. Apart from providing excellent operating conditions for the surgeon, with SA we can avoid any airway manipulation as parturients are considered difficult airway and full stomach and we can also minimize the use of any anaesthetic drugs.

However, SA has its own deleterious effects as well. Spinal anaesthesia can result in severe hypotension which in turn can lead to nausea, vomiting and dizziness to the parturient intraoperatively as well as postoperatively. Hypotension may also cause decrease in uteroplacental blood flow causing fetal acidosis and fetal distress. Hence it is important to identify the parturients having hypotension and promptly treat it. It would be even more beneficial if we could pre-operatively identify those parturients who would suffer from hypotension following SA. This would give anaesthesiologist an opportunity to take adequate measures like pre-loading, co-loading and starting of vasopressors before administration of SA to prevent hypotension [2], and thus help in preventing all the above-mentioned complications associated with hypotension.

Degree of hypotension after SA in each parturient depends upon their baseline peripheral vasomotor tone, their volume status and their sympathetic activity as hypotension occurs due to decrease in the systemic vascular resistance due to blockade of preganglionic sympathetic fibres [3], thus leading to pooling of blood in blocked area. This sympathetic block in turn causes reductions in cardiac output (CO) and Mean Arterial Pressure (MAP), and thus the decrease in perfusion to vital organs and to placenta.

Pregnant women are more likely to develop hypotension following SA due their decreased peripheral vascular tone especially at term and in multiparous women, their more sensitivity to local anaesthetics and less responsiveness to vasopressors [4]. Therefore, parturients with low baseline peripheral vasomotor tone will be at high risk of developing post SA hypotension [5].
There are many methods to access baseline vasomotor tone and sympathetic activity of an individual which might help us to take the required measures to prevent hypotension after SA. Perfusion index (PI), pleth variability index (PVI), parameters of heart rate variability (HRV) and heart rate (HR) are a few such parameters that can be used for the same.
Heart Rate is a useful indicator in knowing patients baseline sympathetic activity. Higher HR suggest higher sympathetic activity and thus higher chances of developing hypotension post SA. Many studies have been conducted for the same.

Perfusion index (PI) is defined as the ratio of pulsatile to non-pulsatile blood flow in the peripheral vascular tissue. It is measured using a pulse oximeter based on the amount of Infrared light absorbed [9]. When peripheral hypoperfusion exists, the pulsatile component decreases but the nonpulsatile component remains same , thus the ratio decreases.

PI can not only be used in assessing hypotension following SA but also monitoring of the depth of anaesthesia, hypothermia, successful epidural placement and response to fluid therapy both in critical care and intra-operatively [5,8]

OBJECTIVES

To evaluate baseline perfusion index of greater than 3.5 (>3.5) as a predictor of intraoperative hypotension following spinal anaesthesia in lower segment caesarean section.

MATERIALS AND METHODS

The present prospective double blinded comparative study was conducted by the Department of Anaesthesia at JSS Medical College and Hospital from November 2019 to July 2021

A total of 28 study subjects were calculated in each group based on the formula

$$\boldsymbol{n} = \frac{2\{(\boldsymbol{a}+\boldsymbol{b})\}^2 \mho^2}{(\boldsymbol{\mu}1-\boldsymbol{\mu}2)^2}$$

1. n = Sample size in each of the groups
- $\mu 1$ = Population mean in treatment Group 1
- $\mu 2$ = Population mean in treatment Group 2
- $\mu 1 - \mu 2$ = The difference the investigator wishes to detect i.e. 15% in our study.
- $\mho$= Population variance (SD)

If a difference of 15% i.e. ($\mu 1 - \mu 2$) between two groups is considered clinically significant

Power = 80%, significance level alpha of 0.05.

- *a* = Conventional multiplier for alpha = 0.05,
- *b* = Conventional multiplier for power=0.80
- Value of a = 1.96, b = 0.842
- $n = 2 \times ([1.96 + 0.842]^2 \times 20^2)/15^2 = 27.9$

Considering the number of dropouts, a total number of 60 parturients were considered out of which 30 parturients were with perfusion index (PI) less than 3.5 (<3.5) and 30 parturients with greater than equal to 3.5 (≥3.5) i.e., 30 parturients in each group.

Inclusion Criteria

- Parturients of ASA Physical status class II
- Undergoing elective lower segment caesarean section under spinal anaesthesia

Exclusion Criteria

- Contra indication to regional anaesthesia- parturients refusal, infection at lumbar puncture site, coagulopathies
- Parturients with placenta previa, preeclampsia, cardiovascular or cerebrovascular disease, gestational diabetes
- Gestational age <36weeks or >41weeks
- Pre-existing abnormal neurological or vascular function of either arm ex.: stroke, spasticity, PVD, diabetes, arteriovenous fistula, or extensive burn wounds
- Allergic reaction to local anaesthetics.
- BMI >30KG/m2
- parturient height <150cm or >170cm

Methodology

Following approval from the Institutional Ethical Committee, informed and written consent was taken from 60 parturients of American Society of Anaesthesiologists Physical status (ASA-PS) class II who were posted for elective lower segment caesarean section (LSCS) under spinal anaesthesia (SA).

After a thorough pre-anesthetic evaluation (PAE) which was done 24 hours prior to the procedure, parturients were posted for elective caesarean section. Standard monitoring with electrocardiography (ECG), automated NIBP (noninvasive blood pressure), heart rate (HR) and pulse oximetry (SpO_2) was done and baseline values of SBP (systolic blood pressure), DBP (diastolic blood pressure), MAP (mean arterial pressure), HR, ECG and saturation were recorded and monitored intra-operatively by using a multipara meter Philips IntelliVue MP20/MP30 monitor. The perfusion index (PI) was measured in the supine position with

wedge under the right buttock to prevent aortocaval obstruction, using a specific pulse oximeter probe (Masimo Mighty Sat Rx Fingertip Pulse Oximeter) which was attached to the left index finger of all parturients to ensure uniformity. While administering neuraxial blockade, the Masimo® pulse oximeter was disconnected to prevent observer bias and SpO_2 was recorded using a different pulse oximeter which did not have the provision of measuring the PI.

This was double-blinded study and all the baseline hemodynamic values including PI were recorded in the supine position (with wedge under the right buttock to prevent aorto-caval obstruction) by an anaesthesiologist who was not involved in the further intraoperative monitoring of the patient.

On basis of baseline PI values, parturients were divided into two groups: -

GROUP 1: -Those with a baseline perfusion index of less than 3.5 (<3.5)

GROUP 2: - those with a perfusion index of greater than equal to 3.5 (≥3.5)

After establishing an intravenous (IV) in the left upper limb, each parturient was prehydrated with 500 ml of Ringer lactate (RL) over 20 min. After pre-hydration, the baseline values were recorded. SA was performed by an anaesthesiologist blinded to the baseline PI values, using Quincke's 25-gauge spinal needle in sitting position with 10 mg of injection bupivacaine 0.5% (hyperbaric) at the L3- L4 inter space. After administration of SA, the parturient were returned to the supine position immediately with a left lateral tilt of 15° to facilitate left uterine displacement with table kept flat and RL was administered immediately at a rate of 200 ml over 10 min for parturients of both the groups as a method of co-loading to prevent sympathetic block induced vasodilatation and hypotension. Oxygen was supplemented through face mask at 6 L/min. The level of sensory block was checked 5 min after the SA by pin prick method with 25G needle with blunted tip. The surgery was allowed to start after the confirmation of sensory block to T6. If T6 sensory block level was not achieved, those parturients were excluded from the study and managed according to institutional protocol.

The following parameters were observed after SA: -

1. NIBP, SBP, DBP, MAP, HR, respiratory rate (RR) and SpO_2 were recorded at 2 min intervals after the SA up to 20 min and then at 5 min intervals till the end of surgery by the same anaesthesiologist who administered SA.
2. Hypotension – Hypotension was defined as decrease in SBP >20% of baseline or <90mmHg and was treated with IV bolus of 6mg injection ephedrine. The number of incidences of hypotension and total amount of ephedrine required and number of doses of ephedrine required were recorded. The first 60 min following spinal anaesthesia was considered for anaesthesia-induced hypotension.
3. Post-operative observation and monitoring of SBP, DBP, HR, ECG, SPO2, MAP was done for 2hours.

Data was entered into Microsoft excel data sheet and was analysed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. Independent t test or Mann Whitney U test was used as test of significance to identify the mean difference between two quantitative variables and qualitative variables respectively. Independent t test was used to compare age, weight, height, body mass index (BMI), pulse- oximetry saturation, APGAR score between two groups.

RESULTS

A total of 30 study subjects were enrolled in both the groups.

Table 1 : Comparison of basic parameters in both the groups

	Group				p value
	Group 1		Group 2		
	Mean	SD	Mean	SD	
Age(years)	26.33	2.97	27.47	3.05	0.15
Height(cm)	159.03	5.04	159.43	5.83	0.777
Weight(kg)	73.27	4.99	73.7	8.11	0.804
BMI(kg/m^2)	29.04	2.56	29.02	3.04	0.974

In the present study, the Mean Age in Group 1(PI<3.5) was 26.33 ± 2.97 years and in Group 2 (PI ≥ 3.5) was 27.47 ± 3.05 years (p= 0.15) and the comparison between mean age of two groups was statistically not significant.

In the present study, the Mean Height in Group 1 was 159.03 ± 5.04 cm and in Group 2 was 159.43 ± 5.83 cm and the difference in the mean height comparison between two groups is statistically not significant. The Mean Weight in Group 1 was 73.27 ± 4.99 kg and in Group 2 was 73.7 ± 8.11kg and the difference in mean weight comparison between two groups is not statistically significant.

In the present study, the Mean BMI in Group 1 was 29.04 ± 2.56 kg/m^2 and in Group 2 was 29.02 ± 3.04 kg/m^2 and there was no statistically significant difference in mean BMI comparison between two groups.

Table 2: Comparison of Mean Perfusion Index comparison

	Group		**p value**
	Group 1	**Group 2**	

	Mean	**SD**	**Mean**	**SD**	
Perfusion Index	2.24	0.77	6.73	2.16	**< 0.001***

In the present study, the Mean Perfusion Index in Group 1 was 2.24 ± 0.77 and in Group 2 was 6.73 ± 2.16 and there was a statistically significant difference in mean Perfusion Index comparison between two groups.

Table 3: Comparison of Episodes of hypotension Distribution

	GROUP 1		GROUP 2	
Episode of hypotension	Number of Parturients	%	Number of Parturients	%
0	22	73.33%	6	20.00%
1	4	13.33%	1	3.33%
2	4	13.33%	15	50.00%
3	0	0.00%	4	13.33%
4	0	0.00%	2	6.67%
5	0	0.00%	2	6.67%

In the present study, 13.33% parturients in Group 1 had 1 Episode of Hypotension, 13.33% had 2 and 73.33% had 0 episodes of hypotension while parturients in Group 2, 20.00% had 0 Episodes of Hypotension, 3.33% had 1, 50.00% had 2, 13.33% had 3, 6.67% had 4 and 6.67% had 5 thus showing that there was a statistically significant difference in episodes of hypotension distribution between two groups.

Table 4 : Comparison of Doses of ephedrine

	GROUP 1		GROUP 2	
No. of Doses	Number of Parturients	%	Number of Parturients	%
0	22	73.33%	6	20.00%
1	4	13.33%	1	3.33%
2	4	13.33%	15	50.00%
3	0	0.00%	4	13.33%
4	0	0.00%	2	6.67%
5	0	0.00%	2	6.67%

In the present study, the Mean Total Amount of Ephedrine in Group 1 was 2.4 ± 4.34 mg and in Group 2 was 12.6 ± 8.54 mg and there was a statistically significant difference in mean Total Amount of Ephedrine administered between two groups.

Table 5: Comparison of Mean SBP Comparison in both the groups

	Group				p value
	Group 1		Group 2		
	Mean	SD	Mean	SD	
Baseline	123.93	8.3	123.6	8.83	0.881
1 min	120.87	8.66	116.03	12.75	0.091
3 mins	107.97	12.12	107.83	14.25	0.969
5 mins	102.03	13.82	99.53	17.32	0.539
7 mins	104.6	12.6	98.67	16.75	0.126
9 mins	107.3	11.27	98.27	13.19	**0.006***
11 mins	109.63	8.32	100.9	15.13	**0.008***
13 mins	110.7	8.68	102.73	15.84	**0.019***
15 mins	112.87	7.7	107.77	15.33	0.109
17 mins	113.3	7.28	111.8	13.54	0.595
19 mins	114.77	6.21	112.83	14.16	0.496
25 mins	116.13	6.3	116.57	9.61	0.837
30 mins	117.13	7.13	119.1	8.77	0.345
35 mins	117.9	6.43	120.67	8.68	0.166
40 mins	118.87	6.19	123.03	7.26	0.02*
45 mins	120.3	6.59	124.17	7.79	0.042*
50 mins	120.37	6.42	126.17	6.77	0.001*
55 mins	121.17	6.64	127.4	6.49	0.001*
60 mins	122.1	6.46	127.57	5.69	0.001*
Post Op	121.97	6.96	126.5	5.91	0.009*

In the present study, there was a statistically significant difference in mean SBP comparison between two groups from 9mins to 13 mins and from 40 mins to Post-operative time. Again there was a statistically significant difference from 40th minute to 60th minute including post-operative period, in these time intervals the systolic blood pressure in both the groups was above 120mmHg and very close to baseline and was clinically not significant.

DISCUSSION

Neuraxial techniques are preferred over general anaesthesia (GA) for lower segment caesarean section (LSCS). Most commonly used neuraxial technique is spinal anaesthesia (SA) unless an indwelling epidural catheter placed for labour analgesia is in situ. SA has many advantages over general anaesthesia. However, SA can result in hypotension, which may cause severe undue adverse effects in mothers, such as nausea, vomiting and dizziness, and may also lead to foetal hypoxia and acidosis.

Decreased vascular resistance due to sympathetic blockade[3]and decreased cardiac output due to peripheral blood pooling in blocked areas of the body is the cause of hypotension after SA in LSCS[10]. In addition to that, in pregnancy women become more sensitive to local anaesthetics, less responsive to vasopressors and have lower mean arterial pressure (MAP) at term[4].Hence, parturients are susceptible to develop profound hypotension following central neuraxial blockade for the LSCS[2].

Peripheral vascular tone is shown to be decreased at term in parturients, especially in multiparous.Decreased peripheral vascular tone results in blood volume being already trapped in the extremities even before SA, and the sympathetic blockade with SA further increases the blood pooling. Therefore, parturients with low baseline vascular tone may be at higher risk of developing hypotension post SA[2].

To prevent SA induced hypotension in parturients, many approaches have been recommended, such as fluid preloading, co-loading, vasopressor agent administration, left uterine displacement with placement of wedge under right buttock, and use of compression stockings. Since the strategies aiming to increase intravascular volume are limited, the use of vasopressor agents has become more and more popular in recent years. However, administration of prophylactic vasopressor agents in parturients may cause undesirable effects on the mother and fetus. An ability to identify those who would suffer from hypotension following SA would give the clinicians an opportunity to take preventative measures.

Therefore, studies have been carried out with non-invasive methods, such as thoracic electrical bioimpedance, measurement of heart rate variability (HRV), cerebral near-infrared spectroscopy, point-of-care ultrasound, perfusion index (PI), and Pleth variability index (PVI) to predict which parturient would develop hypotension[11].

Perfusion Index (PI) is one such non-invasive parameter that can be used. “PI is defined as the ratio of pulsatile blood flow to non-pulsatile blood flow in the peripheral vascular tissue, measured using a pulse oximeter based on the amount of Infrared light absorbed[5]”. Healthy pregnancy is characterized by a decrease in systemic vascular resistance, increased total blood volume and cardiac output. The decrease in tone corresponds to higher perfusion index values due to increase in pulsatile component due to vasodilatation. PI gives an indication of the status of microcirculation, heavily innervated by sympathetic fibers, and therefore, is affected by many factors responsible for vasoconstriction or vasodilatation of the

microvasculature. Hence, PI can be used to assess perfusion dynamics and is being considered as a non-invasive method to detect the likelihood of development of hypotension following subarachnoid block (SAB)[5,7,12]. Various studies carried out previously have employed perfusion index to assess hemodynamic parameters.

The Mean Perfusion Index in both the groups showed statistically significant difference. In Group 1 mean PI was 2.24 ± 0.77 and in Group 2 it was 6.73 ± 2.16. From our study, based on ROC curve we derived a more appropriate cut-off of 3.8 with sensitivity of 75% and specificity of 85.71%. Similar results were found by

Joseph George *et al* [13], in their prospective observational study, yielded a new baseline PI value of 3.6 as the cut-off point with a sensitivity of 80% and specificity of 40%.

Duggappa *et al* [9], showed that the incidence of hypotension in Group I (PI ≤3.5) was 10.5% (6/57) compared to 71.42% (45/63) in Group 2 (PI>3.5) which was clinically and statistically highly significant ($P < 0.001$, odds ratio –0.07). Incidence of hypotension in both groups was lesser in this study compared to our study, as the hypotension in this study was defined as a decrease in MAP <65 mm of Hg regardless of the baseline blood pressure of the parturients. Also, spinal anaesthesia was given in left lateral decubitus position rather than sitting position as in our study which can further add to cause of lesser incidence of hypotension. When SA is administered in sitting posture and the parturient is immediately brought to supine posture, the drug can ascend high-up rapidly in the intrathecal space.

Joseph George *et al* [13], also showed a significant correlation between baseline PI >3.6 and hypotension. In their study they have not specified the exact number of patients developing hypotension in the groups with lower or higher PI values.

In our study, the Mean Total Amount of Ephedrine required in Group 1 was 2.4 ± 4.34 mg and in Group 2 was 12.6 ± 8.54 mg which was highly significant ($p < 0.001$).

Patel N *et al* [15], showed that the median dose requirement of Inj. Mephentermine in group 1(PI<4.0) was 0.00 mg (0-12) compared to dose in group 2 (PI>4.0) being 6.0 mg (0-18) (p=0.00028). The amount of ephedrine used in this study is lesser than our study. This difference is mainly due to the definition of hypotension in their study being decrease in MAP of more than 20% irrespective of the baseline values of each individual irrespective of the baseline blood pressure of the parturients. And also, they have taken the median value of the ephedrine usage in both the groups. In our study, the definition for hypotension is decrease of systolic pressure of more than 20% or less than 90mm Hg and in our study, we have considered the mean value of the use of ephedrine.

CONCLUSON

In conclusion, our study demonstrated that higher baseline perfusion index (PI) of greater than 3.5 (>3.5) correlates with higher incidence of hypotension and higher use of ephedrine to treat the hypotension after spinal anaesthesia (SA) for lower segment caesarean section. Thus, PI can be used as a non-invasive everyday monitor to identify the parturients with the likelihood of developing hypotension post SA and take adequate preventive measures. We also derived 3.8 as a new cut-off value for PI with sensitivity of 75% and specificity of 85.71% above which more hypotension was observed.

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