



Perfusion Index Assessed from a Pulse Oximeter as a Predictor of Hypotension during Spinal Anaesthesia for Caesarean Section

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Abstract

Background and Aims: Hypotension during spinal anaesthesia for caesarean section is a common and important problem with foetal and maternal implications. Perfusion Index (PI) observed from a pulse oximeter has been used for assessing peripheral perfusion dynamics due to changes in peripheral vascular tone. The aim of this study was to determine whether a baseline PI can predict hypotension after spinal anaesthesia for caesarean section.

Methods: In this prospective observational study, 60 pregnant women were divided into two groups on the basis of PI. Group I included those with $PI > 3.5$ and group II, those with $PI \leq 3.5$. Spinal anaesthesia was given with 2ml of 0.5% bupivacaine (hyperbaric) in L3-L4 or L2-L3 inter space. A mean arterial pressure (MAP) of < 65 mm of Hg is defined as hypotension. Statistical analysis was performed using independent sample t-test and chi-square test. Receiver operating characteristic (ROC) curve was plotted for PI and occurrence of hypotension.

Results: The incidence of hypotension is 86.67% in group I whereas it is 6.67% in group II. The correlation between baseline $PI > 3.5$ and the number of episodes of hypotension and the dose of vasopressors was also significant. The sensitivity and specificity of baseline PI of 3.5 to predict hypotension was 86.67% and 93.33% respectively. The area under the ROC curve for PI to predict hypotension was 0.911.

Conclusion: The incidence of hypotension following spinal anaesthesia for caesarean section is high in parturient with baseline $PI > 3.5$.

Keywords: Perfusion index, spinal anaesthesia, hypotension, pregnancy.

Introduction

Hypotension during spinal anaesthesia for caesarean section is a result of decreased vascular resistance due to blockade of preganglionic sympathetic fibres by spinal anaesthesia and decreased cardiac output due to pooling of blood in blocked areas of body¹. Changes in baseline peripheral vascular tone due to pregnancy may also have an influence on the degree of such

hypotension. Studies have demonstrated a reduction in peripheral vascular tone in healthy pregnancy¹⁶. Perfusion Index assessed from a pulse oximeter has been used for assessing peripheral perfusion dynamics due to changes in peripheral vascular tone¹. Perfusion Index is the ratio of the pulsatile blood flow to the non-pulsatile blood flow in the peripheral vascular tissue, measured using a pulse oximeter based on the amount of infrared light absorbed.⁵ It can be

measured noninvasively and is being considered as noninvasive method to predict hypotension following subarachnoid block. (SAB)^(4,6,7). It is likely that parturients with low baseline vascular tone are more risk to develop hypotension than those with relatively higher baseline vascular tone. Peripheral vascular tone can be measured by plethysmography but it is invasive and is not readily available for clinical management.⁶ PI is the numerical value of the amplitudes of the plethysmographic-pulse wave that is displayed on pulse oximeter. This study was conducted to determine whether a baseline PI >3.5 can predict hypotension after spinal anaesthesia for caesarean section.

Methods

This prospective observational study was conducted after getting ethical clearance from the institutional review board. Informed written consent was obtained from every participant in the study. Study population included pregnant women between 20 and 35 yrs of age posted for elective caesarean section. Pregnant women with placenta previa, preeclampsia, cardiovascular and cerebrovascular disease, gestational diabetes, body mass index ≥ 40 , gestational age <36 or > 41 wks, contraindications to spinal anaesthesia were excluded from the study. Standard monitoring with electrocardiography, Automated noninvasive blood pressure (NIBP) and pulse-oximetry (SPO2) was done for baseline values and intra operative monitoring. The left index finger was used in all participants for perfusion index monitoring, using a Truscope touchmonitor in which the masimo module is intended to monitor the PI of the patient. The baseline PI was measured in the Supine position. Those with a baseline PI >3.5 fell into group 1 and those with a baseline PI ≤ 3.5 fell into group II. Each pregnant woman was prehydrated with 500ml Ringer lactate over 20 minutes by an intravenous access secured in the left upper limb. After prehydration, baseline heart rate (HR), SPO2, NIBP and PI were recorded. Spinal subarachnoid block was performed with

10mg of 0.5% bupivacaine (hyperbaric) in L3-L4 or L2-L3 inter space in the left lateral position. The parturient was returned to the supine position with a left lateral tilt of 15° to facilitate the uterine displacement. Oxygen was given through face mask at 4 L/ minute. The sensory level of block was checked with a cold swab and at 5 minutes, if a level of T₆ was not reached, they were excluded from the study. Maximum cephalad spread 20 minutes after subarachnoid block was noted. NIBP, HR, Respiratory Rate (RR), SPO2 and PI were recorded at 2 minutes intervals. Hypotension was defined as a decreases in MAP <65mm of Hg, and treated with IV bolus of 6 mg injections ephedrine and IV fluids. Hypotension in the first 60 minutes following spinal anaesthesia was considered for anaesthesia induced hypotension.

Results

A total of 60 pregnant women were included in the study. 30 patients were the group I and 30 were in group II. The demographic parameters such as age and BMI were comparable in each group. Baseline heart rate and mean arterial pressures (MAP) also were comparable between the two groups. The median PI in group I was 7.18 and the PI in group II was 2.69. The incidence of hypotension in group I was 86.67% whereas it is 6.67% the group II. This was statistically highly significant ($p < 0.05$). In group I, 11 patients had one episode and 12 patients had 2 episodes and 3 patients had 3 episodes of hypotension. In group II, 93% of pregnant women had no hypotension. One pregnant woman had one episode of hypotension one had two episodes of hypotension. 50% of parturients in group I had multiple episodes of hypotension. The requirements of vasopressors also were more in group I parturients. The significant level was found out with statistical technique using independent sample t test Chi-square test and ROC curve. ROC curve yielded 3.83 as a more appropriate cut-off value with a well balanced 86.67% sensitivity and 93.33% specificity, positive predictive value of 92.86% and negative predictive value of 87.5%.

Table 1 Comparison of demographic characteristics between two groups

| Demographic Parameter | Group I PI >3.5 | Group II PI ≤3.5 | P value |
|-----------------------|--------------------|---------------------|---------|
| Age | 30.77 | 29.83 | 0.296 |
| BMI | 22.97 | 21.47 | 0.121 |

Table 2: Comparison of baseline heart rate and MAP between two groups

| | Group I PI >3.5 | Group II PI ≤3.5 | P value |
|---------------------------|--------------------|---------------------|---------|
| Baseline HR | 94.70 | 93.93 | 0.844 |
| Baseline BP (MAP)mm of Hg | 87.93 | 92.27 | 0.092 |

HR= Heart Rate, MAP=Mean Arterial Pressure

Table: 3 Frequency wise comparison of no.of episode of hypotension between the groups

| No. of episodes of hypotension | No.of patients | | Total | P value |
|--------------------------------|-------------------|---------------------|-------|---------|
| | Group I PI>3.5 | Group II, PI≤3.5 | | |
| 0 | 4 | 28 | 32 | 0.000 |
| 1 | 11 | 1 | 12 | |
| 2 | 12 | 1 | 13 | |
| 3 | 3 | 0 | 3 | |
| Total | 30 | 30 | 60 | |

Table: 4 No. of doses of vasopressors required between the groups

| No.of doses of vasopressors | No.of patients | | Total | P value |
|-----------------------------|-------------------|--------------------|-------|---------|
| | Group I PI>3.5 | Group II PI≤3.5 | | |
| 0 | 4 | 28 | 32 | 0.000 |
| 1 | 11 | 1 | 12 | |
| 2 | 12 | 1 | 13 | |
| 3 | 3 | 0 | 3 | |
| Total | 30 | 30 | 60 | |

| | |
|---------------------------|--------|
| Positive | |
| True Positive | 26 |
| False Negative | 4 |
| Negative | |
| False Positive | 2 |
| True negative | 28 |
| | |
| Sensitivity | 86.67% |
| Specificity | 93.33% |
| Positive Predictive value | 92.86% |
| Negative Predictive value | 87.50% |

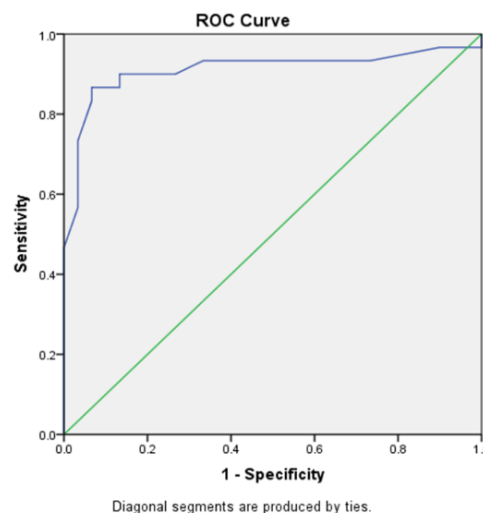


Figure 1: ROC curve depicting baseline PI against incidence of hypotension

| Area under the curve | | | | |
|----------------------|------------|---------|------------------------------------|-------------|
| Area | Std. Error | P value | Asymptotic 95% Confidence interval | |
| | | | Lower Bound | Upper Bound |
| 0.911 | 0.044 | 0.000 | 0.823 | 0.998 |

Discussion

In the present study, the incidence and severity of hypotension and vasopressor requirement were higher in pregnant women with PI>3.5 than those with PI≤ 3.5. The ROC curve showed that PI differentiated well between pregnant women who developed hypotension and those who did not develop hypotension. The ROC curve yielded 3.83 as a more appropriate cut-off with a well balanced 86.67% sensitivity and 93.33% specificity. It yielded a new baseline PI value of 3.83 as the cut-off point for predicting hypotension in pregnant patients undergoing caesarean section under spinal anesthesia. Hypotension during spinal anaesthesia for cesarean section remains a problem with attendant maternal and foetal morbidity and the use of vasopressor to treat it is required upto 80% of anaesthesia.² None of the monitoring system is definite in predicting the likelihood of hypotension, so that additional precaution may be taken. Studies have tried to evaluate the usefulness of perfusion index in predicting

hypotension following spinal anaesthesia in caesarean section.⁸ The results of study by Hanss R et al suggests that hemodynamic changes of spinal anaesthesia for cesarean section are influenced not only by volume status and sympathetic activity but also by vascular tone. They demonstrated that high baseline PI > 3.5 was associated with profound hypotension after spinal anaesthesia.² The principle of spO_2 is based on two light sources with different wavelengths 660nm and 940 nm emitted through cutaneous vascular bed of finger or earlobe⁴. The absorbance of both wave length has a pulsatile component which represents fluctuations in the volume of arterial blood between the source and the detector. The non-pulsatile component is from connective tissue, bone and venous compartment. The perfusion index (PI) is the ratio of the pulsatile component (arterial) and non-pulsatile component of light reaching the detector. The reduction of systemic vascular resistance may vary in pregnant women and is dependent on various factors.^(10,16) This decrease in tone will correspond to higher perfusion index values due to increase in pulsatile component due to vasodilatation. Spinal anaesthesia by induction of sympathectomy will cause a further decrease in vascular tone and hypotension. Pregnant women with high baseline perfusion index have lower peripheral vascular tone and hence at higher risk of developing hypotension following spinal anaesthesia. The reliability of PI to detect vasoconstriction has been demonstrated by Mowafi et al in the study to detect intravascular injection of epinephrine containing epidural test dose.¹² In this study the cut off value of baseline PI for prediction of hypotension following spinal anaesthesia was chosen as 3.5. In the study by Toyoma et al they did regression analysis and ROC curve analysis and concluded that a baseline PI cut off point of 3.5 could be used to identify pregnant women at risk of hypotension following spinal anaesthesia based on the above study.⁸ The baseline PI > 3.5 and probability of hypotension were significantly correlating in this study. This is a finding similar to

study by Toyoma et al. A highly significant correlation was found between baseline PI > 3.5 and number of episodes of hypotension and the total dose of ephedrine used. In this study requirement of vasopressor was also more in those with PI > 3.5. Same findings were seen in a study by Devika Rani Duggappa et al.¹¹ They found sensitivity of 89.29% and specificity of 69.84% respectively for baseline PI with a cut off of 3.5 to predict hypotension, whereas in this study, the sensitivity 86.67% and specificity 93.33% respectively. Toyoma et al found a sensitivity and specificity of 81% and 86% respectively. There are many limitations in this study. Any stimulus like anxiety increasing sympathetic activity and patient movement could change the PI values. In this study the baseline PI was recorded with care to avoid patient movement and patients were counselled before surgery to allay anxiety.

Conclusion

Perfusion index (PI) can be used as a predictor of hypotension in pregnant women during spinal anaesthesia for caesarean section. Those with baseline PI > 3.5 are at higher risk of developing hypotension following subarachnoid block compared to those with baseline PI ≤ 3.5.

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