# Prediction of hypotension using perfusion index following spinal anesthesia in lower segment caesarean section

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## ABSTRACT

**Aims:** To correlate the relation between perfusion index and the prediction of hypotension in lower segment caesarean section.

**Methods:** This is a prospective observational study of parturients undergoing caesarean section from 4th February to 2nd June 2020 at Paropakar Maternity and Women's Hospital in Kathmandu. Cases were studied by their Perfusion Index (PI) value of 3.5 as cut-off. parturients undergoing caesarean section. Hemodynamic effects and PI values were monitored recorded and compared between low and high PI groups. Statistical analysis was done using independent sample T test and Pearson correlation.

**Results:** Total 106 cases were studied with 52 with low PI value and 54 cases with high PI value. The incidence of hypotension in low PI was 26% whereas it was 48% in high PI group and mean consumption of phenylephrine was more in high PI group.

**Conclusions:** Parturients with a higher baseline PI index of more than 3.5 have more incidence of hypotension and require vasopressors support following spinal anesthesia in elective LSCS

**Keywords:** Caesarean section; Hypotension; Perfusion index; Spinal anesthesia; Vasopressors;

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## INTRODUCTION

Providing safe yet adequate anesthesia in obstetric patients is very challenging for every anesthesiologist. The physiological changes associated with pregnancy make every pregnant woman vulnerable for various intra-operative upheavals that often complicate and threaten the lives of the mother and the fetus.[1] For caesarean sections (CS), subarachnoid block (SAB) is the most commonly performed anesthesia for various reasons pertaining to maintaining the safety of the mother and fetus.

Perfusion index is defined as the ratio of pulsatile blood flow to non-pulsatile blood flow in the peripheral tissues and it is measured using a relatively cheap, and non-invasive pulse oximeter.[2]

The use of perfusion index (PI) as a dynamic measure of vascular responsiveness and its use in prediction of hypotension will certainly create a new approach to patient safety. There are, however, very scarce articles on the use of this innovative strategy for patient management and most of which have shown promising results[3-5] but some studies[6] have produced equivocal results to the use of this technique. It is very difficult in a country like ours from financial, technical, and ethical point to use invasive and/or costly non-invasive monitoring techniques to guide fluid/vasopressors in cases of expectant hypotension. Thus, study using perfusion index which require only meager resources will certainly help in a cost-effective management of patient at times of hypotension. There are also very limited to no such studies being conducted in this part of the world also provides us enough impetus to conduct such study in our center.

## METHODS

An observational analytical study was performed from 4th February to 2nd June 2020 at Operation Theater of Paropakar Maternity and Women's Hospital in Kathmandu which is the tertiary level public hospital with more than 6000 cesarean section

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annually. Parturient women were classified by perfusion index (PI) cut-off of 3.5 as low (<3.5) and high PI (≥3.5) group for the purpose of comparison. IRC approval was taken and a written informed consent was obtained. The inclusion criteria were ASA II physical status, planned for elective LSCS, gestational age >36 weeks and <41 weeks, and age 20 years to 35 years. Cases excluded were patients with contraindications to spinal anesthesia, BMI >40, preeclampsia, placenta praevia, and comorbidities like cerebrovascular or cardiovascular disease, and gestational diabetes. For all planned surgery patients were instructed to remain fasted for 8 hours for solid food, 6 hours for liquid and 2 hours for clear liquid. No oral premedication was given.

On receiving the subject in the holding area, baseline hemodynamic parameters (including SBP, DBP, MAP, and PI) were recorded and PI was measured again at supine position. With Lifescope™ monitor by an anesthesiologist who was not involved in any other part of the study. Patients were kept in supine position and baseline PI was recorded. According to baseline PI subjects were divided into two groups, Group I had a PI index of <3.5 and Group patients had a PI index of ≥3.5. Following pre-hydration, next set of baseline vitals were recorded and premedicated with intravenous Metoclopramide 10 mg and Ranitidine 50 mg.

The parturient was then subjected to routine neuraxial blockade using standard technique in standard set up based on hospital's protocol. During the administration of neuraxial anesthesia, the pulse oximeter was disconnected to prevent observer bias and SpO2 was recorded using portable pulse oximeter. Spinal anesthesia was performed by an anesthesiologist who was blinded to the baseline PI values, using 25G Whitacre spinal needle (PENCAN) in left lateral decubitus position with 11 mg of 0.5% hyperbaric Bupivacaine (Anawin heavy 0.5%, Neon Laboratories, India) total volume of 2.2 ml at either L3-L4 or L4-L5 inter-space. The parturient was then shifted back to supine with left lateral uterine displacement of $15^0$ by tilting of the bed or manual displacement. The (Lifescope™) pulse oximeter was reconnected to monitor the patient until the end of surgery. Throughout the surgical procedure, the parturient was provided with oxygen supplementation via nasal cannula at 2l/min.

During the surgery, Ringer's lactate was given at 600 ml/hr. The level of sensory block at 5 minutes was checked using cold ice pack and recorded in the proforma. Failure to achieve a level of T6 at 5 minutes following spinal resulted in exclusion of the parturient from the study and case was managed accordingly to the standard institutional protocol.

Maximum cephalad spread of local anesthetic was recorded at 20 minutes following SAB. Vitals such as NIBP, HR, RR, SpO2 and PI were recorded continuously at 2 minutes interval for the first 20 minutes, then at 5 minutes interval until the end of surgery by the same anesthesiologist who administered the spinal anesthesia.

Hypotension was defined as fall in MAP <65 mm Hg and treated with IV bolus of Inj. Phenylephrine 100 mcg along with 100 ml of Ringer's lactate. The first 60 minutes following administration of spinal anesthesia was considered for spinal induced hypotension. Bradycardia was defined as HR <50 beats/min and treated with Inj. Atropine 0.6 mg IV bolus.

Following extraction of the baby, Apgar score was recorded at $1^{st}$ and $5^{th}$ minutes. Following the delivery of the baby, Inj. Oxytocin 3 U was given as bolus and other 10 U will be given at 200mU/min as a separate infusion if required as per the surgeon. Parturient requiring additional oxytocics and/or additional interventions were excluded from the study.

The incidence of other side effects including nausea and vomiting were recorded and was managed by supportive management and giving injection Ondansetron 0.1 mg/kg IV. Repeated episodes of vomiting within 5 minutes were recorded as one. Calculated sample size by 30% expected change (as obtained from a pilot study) obtained at least 44 in each study group. Data were entered in SPSS version 23 for statistical analysis.

## RESULTS

A total of 106 patients were included in the study out of which 2 were excluded due to inadequate level of spinal blockade, 3 were excluded due to increased requirement of oxytocics and 1 was excluded due to conversion to GA. there were 52 cases in low PI group and 54 in high PI group. The demographic parameters such as age weight and height were comparable between the two groups.

**Table-1: Demographic parameters of grouped by perfusion index (N=106)**

| Demographic parameters | Low PI (n=52) | High PI (n=54) | p- value |
|---|---|---|---|
| Age in years | 27.24 | 27.66 | 0.75 |
| Weight in kg | 68.26 | 66.84 | 0.46 |
| Height in inches | 63.02 | 62.10 | 0.10 |

The median level of cephalad spread of sensory block was T6 in both the groups. The mean baseline PI value of low PI group was 1.73 ±.72 and that of high PI group was 5.37±1.79 which is expected as the parturients were divided according to values of more than 3.5 or less than 3.5 based on the study of Toyama et al, PI values for the rest of the study were statistically insignificant. Intraoperatively the mean HR of both the groups was stable and uneventful; none of the patients had any episode of bradycardia and did not receive atropine or any other rescue drugs. The mean HR between the two groups was statistically insignificant.

The mean baseline blood pressure between the two groups was statistically insignificant with a mean SBP of 123.44±14.07 in low and 121.6 ±15.08 in high PI group. There was statistically significant difference from 4$^{th}$ to 10$^{th}$ minutes ($p<0.05$) [Figure-1].

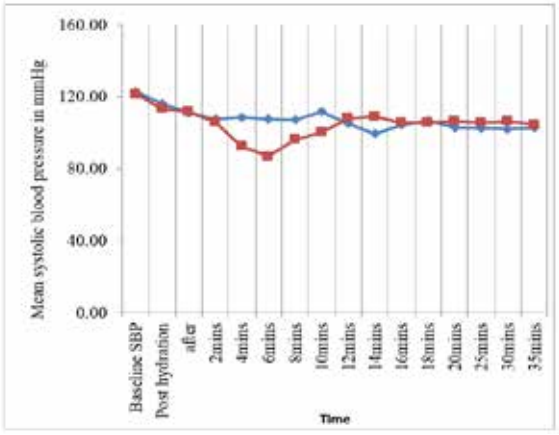


**Figure-1: Systolic blood pressure low PI (yellow) and high PI (red) groups**

The baseline mean DBP between the two groups were comparable with mean DBP for both groups (81.6±11.30 and 77.92 ±11.45) but there was statistically significant difference in 4$^{th}$ and 6$^{th}$ minute [Figure-2].

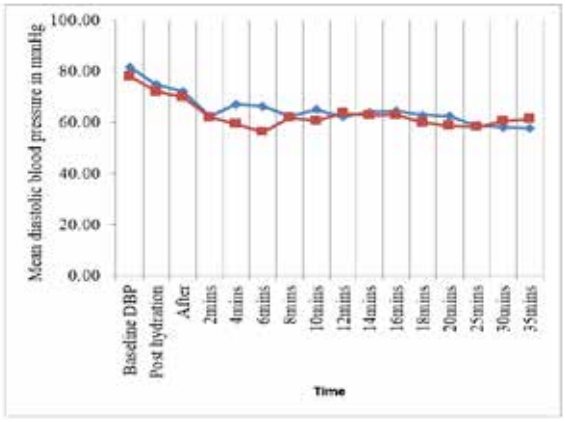


**Figure-2: Diastolic blood pressure in low PI (yellow) and high PI (red) groups**

From the above result we can assume that the systolic blood pressure is affected more than the diastolic pressure during spinal anesthesia in parturients and adding to that, the group of parturient with a low PI index has less decrease in both systolic and diastolic pressure as compared to parturients with a high PI index.

The baseline mean arterial pressure between the two groups were comparable with mean MAP (92.3±11.38 and 87.32±20.29) ($p=0.13$) except in 6$^{th}$ minute. Hence from this we can assume that the mean arterial pressure is not well affected as compared to systolic and diastolic pressure.

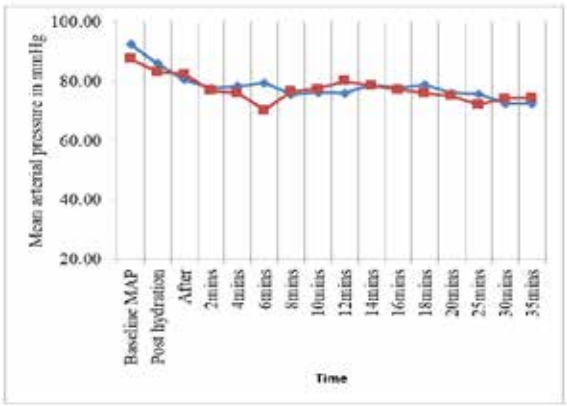


**Figure-3: Mean arterial blood pressure in low PI (yellow) and high PI (red) groups**

The incidence of hypotension between the two group were statistically significant as 26% (14 in 52) patients of low PI had incidence of hypotension requiring vasopressors support whereas there was a large percentage (48%; 26 in 54) of patients with high PI required it. The mean phenylephrine consumption was also significantly higher ($p=0.03$) in high PI

group (122.41±57.61 vs 94.64 ±9.03).

The Respiratory rate and $SpO_2$ were comparable between the two groups throughout the whole study period, There were no significant APGAR score differences between the groups in the 1st and the 5th minute; and the incidence of nausea and vomiting were similar in both the groups.

On spearmans rank correlation we found a highly significant co relation between baseline PI of >3.5 and number of episodes of hypotension ($r_s = {}_0.26$ and $p<0.05$) [Figure-4].

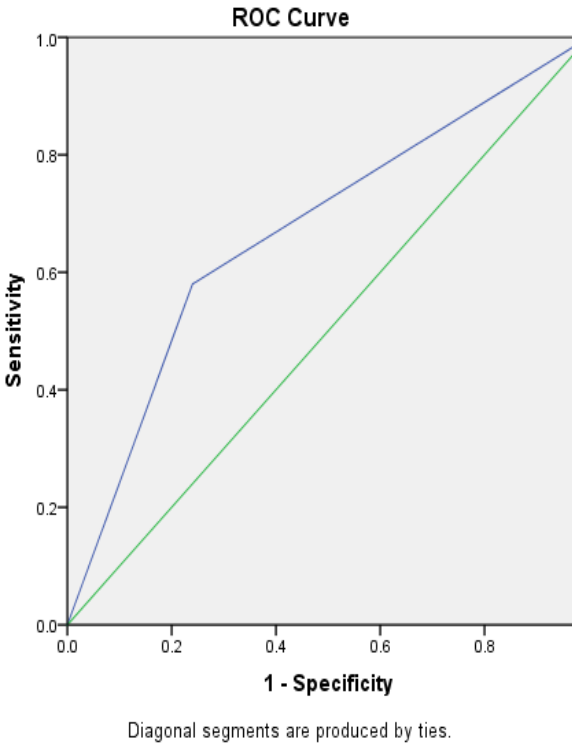


**Figure-4: Spearman rank correlation between baseline PI and hypotension**

## DISCUSSION

The present study was done to determine whether patients with higher baseline PI value were more susceptible to hypotension after spinal anesthesia. The results conclude that parturients with higher PI of >3.5 had higher number of episodes of hypotension.

Hypotension is one of the most common side effects of spinal anesthesia and there are definite indicators which predict the likelihood of hypotension. Studies have tried to evaluate the usefulness of perfusion index as a predictor for hypotension following spinal anesthesia in parturients because there are no non invasive methods which can predict the likelihood of hypotension.

The principle[7] of $SpO_2$ is based on two light sources with different wavelength, 660 nm and 940 nm emitted through the cutaneous vascular bed of finger or ear lobes based on Beer- lamberts law. The absorbance of both the wavelength has a pulsatile component, which is then presented as fluctuations in volume in the arteries between the source and the receptor or detector. The non-pulsatile component is from the bones and tissues, the perfusion index (PI) is the ratio between the pulsatile and non-pulsatile component.[8]

In a normal pregnancy, there is a decrease in systemic vascular resistance and increase in blood volume and cardiac output, due to various factors. The decrease in systemic vascular resistance in different parturients is varied due to various factors. As there is an increase in flow due to decrease systemic vascular resistance this will lead to a pulsatile component in the arteries and hence leading to a higher PI index in the vasodilated state. Induction of sympathetectomy by methods such as spinal anesthesia leads peripheral pooling of blood and hypotension.

Parturients with higher PI index are expected to have a decreased peripheral vascular tone and are at higher risk of developing hypotension, following sympathetectomy, PI index has been used by Mowafi et al[9] to detect intravascular injection of epinephrine containing test dose during epidural anesthesia, Ginosar et al[10] demonstrated sympathetectomy by an increase in PI following epidural anesthesia. From the mentioned studies we can assume that that PI index can be used as a reliable indicator of vascular tone.

The baseline cutoff value for PI of 3.5 was based on a study conducted by Toyama et al[4] who did regression analysis and ROC analysis and identified 3.5 to be a cut off value which was based on the fact that decrease in vascular resistance is related to the number of gravidity and parity. As the study conducted by Toyama et al[4] where he conducted study to identify 3.5 as the cut off value in Japanese population, we did not try to explore and correlate to refute or challenge this baseline PI in our Nepalese population.

On Spearman rank correlation, there was low

correlation found between the incidence of hypotension, total dose of phenylephrine used and the total IV fluid consumed in parturients with baseline PI value of >3.5.

The correlation of incidence of hypotension and PI index was found to be highly significant with 26 patients out of 54 patients had hypotension whereas only 14 patients out of 52 patients had hypotension, the correlation between the total dose of phenylephrine and PI was not significant (p=0.078). The correlation of PI index and total fluid consumption was not significant p=0.74), hence we did not find a significant correlation between incidence of hypotension and total dose and phenylephrine and total fluid consumption and PI index.

Toyama et al[4] found a sensitivity and specificity of 81% and 86% respectively for baseline PI with a cut off of 3.5 to predict hypotension, our study showed a sensitivity of 58% and specificity of 24%. The differences may be due to differences in methodology, as in the other study the definition of hypotension decrease in SBP of more than 25% of baseline, co loading used in the other study if of colloid whereas we used crystalloid in our study, other factors may also play a role such as patient movement, anxiety, operating room temperature. In our study we set the operating room temperature at 25 degrees centigrade and also asked the patient to be calm, but these are the only measures we could do to comfort and allay anxiety in a parturient who could not be given any form of medication before the delivery of the fetus.

Uterotonics such as prostraglandins F2 alpha and, methylergometrine would have influenced the vascular tone and parturients receiving these drugs were excluded from the study as they received these drugs 20 and 25 mins after spinal anesthesia.

There are many limitations to our study such as anything that increases the sympathetic activity of the patient such as anxiety can easily influence the PI value, other factors such as movement of the hand. In our study we took various precautions to record the baseline PI index value, all patients were counseled before the surgery to allay anxiety, all the baseline record were done in supine position on the same hand of every patients, all of the reading were done in left lateral position to decrease the effects of aorto-caval compression.

Our study has various limitations as we did not use parameters such as stroke volume, calculation of total peripheral resistance, and as it were cases of elective caesarean sections, we did not use invasive procedures such as invasive arterial pressure monitoring or central venous pressure. Secondly the pulse oximeter is subjected to changes due to anxiety, patient movement and discomfort or any other stimuli that will result in increase in sympathetic activity.

Secondly due to financial constraints and institutional protocol we could not use colloid for preloading or co loading the patient as studies have shown preloading or co loading with colloid had various benefits over crystalloid.

## CONCLUSIONS

Prediction of post spinal hypotension in caesarean section is an interesting prospect as it allows better care for the parturient, PI index is a simple safe and very easy method to predict hypotension intra operatively. PI with values of <3.5 have less incidence of hypotension and values of ≥3.5 have more incidence of hypotension but it cannot be used alone as a tool due to its low sensitivity and specificity.

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