Original Article

Prediction Of Hypotension Using Perfusion Index Following Spinal Anesthesia In Lower Segment Caesarean Section

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Abstract

Objective: To study the association of baseline Perfusion index with intraoperative hypotension in obstetric patients undergoing lower segment cesarean section in spinal anesthesia.

Methods: A Prospective observational study was conducted in the Anesthesia Department of Pak Emirates Military Hospital, Rawalpindi from 1st Jan 2025 to 1st Oct 2025.

A total of 300 pregnant patients scheduled for spinal anesthesia for lower segment cesarean section were recruited for the study. Patients' clinical data, including perfusion index was noted. After spinal anesthesia, the incidence of intraoperative hypotension and the treatment provided were noted. Mean and SD were calculated for Age, basic metabolic index, Perfusion Index, and time to hypotension. Student t test was applied to see the difference between the hypotensive and non-hypotensive groups.

Results: The mean age of the patients included in our study was 27.99±3.81 years. The distribution of women as per PI group was comparable, as 49% women had PI <3.5% and 51% woman had PI >3.5%. There was no statistically significant difference between age (p-value = 0.93), BMI (p-value = 0.11), and baseline systolic blood pressure between 2 groups. PI of Group A was 4.18 ± 1.33 Group B was 2.64 ± 0.93(p-value < 0.001). The Area Under the Curve (AUC) yielded as 3.5 optimal cutoff value with Sensitivity 79% and Specificity: 74%. Area under curve yielded 0.84 (95% CI: 0.76–0.92) with Optimal cutoff value for PI: >3.5, having Sensitivity of 79% and Specificity of 74%.

Conclusion: Perfusion index is a simple, safe, rapid, and reliable method that can predict intraoperative hypotension through pulse oximetry at the fingertip. A high PI of 3.5 or above can be used as a cutoff to predict hypotension along with other methods.

Keywords: Hypotension, Lower Segment Cesarian Section, Perfusion Index.

Introduction

Spinal anesthesia is considered a suitable choice for the cesarean section, due to its easy and early mode of onset, decreased systemic toxicity, and prevention of pulmonary aspiration.[1,2] However, one of the consequences of spinal anesthesia is maternal hypotension, which occurs in approximately 60-70% of cesarean deliveries.[3-4] It may adversely affect the mother and fetus. Several factors are implicated in maternal hypotension during spinal anesthesia, including compression of the aorta by the gravid uterus during the supine position and vasodilation due to loss of sympathetic supply.[5-7] Furthermore, chemical intervention in the form of vasopressor intraoperatively may lead to the risk of acute pulmonary edema, fetal acidosis, and maternal arrhythmias.[8] This is why many researchers in the field of obstetric anesthesia have done extensive studies to find causes and anticipatory options for intraoperative maternal hypotension treatment.
There are many noninvasive methods to detect, including baseline vasomotor tone, heart rate variability, skin temperature, and perfusion index. Perfusion index is a simple, noninvasive, and easy parameter measured through pulse oximetry. It is the ratio of pulsatile blood to non-pulsatile or static blood in peripheral tissue, and it provides indirect measurements of tissue perfusion.[9,10] A normal perfusion index value ranges between 0.02% to 20%.

There is a paucity of research on the topic of whether PI correctly predicts hypotension, so we aim to study the correlation between the perfusion index and hypotension and validate the association of demographic factors, including age, height, weight, and BMI, at the local setup.

Materials And Methods

We conducted this prospective observational study in the Department of Anaesthesiology at Pak Emirates Military Hospital, Rawalpindi from 1st Jan 2025 to 1st Oct 2025. The sample size was calculated using the formula for estimating a single proportion in a population. The primary outcome was the incidence of post-spinal hypotension in parturients undergoing elective lower segment caesarean section (LSCS). Reference was made to the landmark study by Toyama et al., which reported a baseline perfusion index (PI) > 3.5 as a predictor of hypotension with a sensitivity of 81% and specificity of 85%.[11] Assuming an expected incidence of spinal-induced hypotension of approximately 60% (0.60) based on previous literature, with a 95% confidence level (Z = 1.96) and a margin of error (precision) of 5% (0.05), the sample size was calculated as follows:

$n=Z^2\times p\times(1-p)/d^2$

$n= (1.96)^2\times0.60\times (1-0.60) / (0.05)^2$

$N=0.05)^2(1.96)^2\times0.60\times(1-0.60)$

$n=3.8416\times0.60\times0.400.0025$

$n=0.00253.8416\times0.60\times0.40$

$n=0.0025/ 0.922\approx369$

After taking permission from the Hospital Ethical Review Board with ERC number ERC/01/25, informed consent was obtained from patients. All patients scheduled for elective cesarean section were instructed to remain nil per os for 8 hours before surgery.

All patients with American Society of Anesthesiology (ASA) II physical status, planned for elective LSCS, gestational age >36 weeks and <41 weeks, and age 18 years to 45 years were included in the study.

Patients with contraindications to spinal anesthesia, BMI >40, preeclampsia, placenta previa, and comorbidities like cerebrovascular or cardiovascular disease, and gestational diabetes were excluded from the study. For all planned surgery patients were instructed to remain in fast for 8 hours for solid food, 4 hours for liquid, and 2 hours for clear liquid. No oral premedication was given.

After taking demographic data, the patient's Perfusion Index was noted with the help of the monitor. Following pre-hydration with Ringer's lactate (10 ml/kg), patients were given a neuraxial block as per the standard operating protocol of the hospital. Spinal anesthesia was given using 25 G Whitacre spinal needle in the sitting position with 12.5 mg of 0.5% hyperbaric Bupivacaine. A total volume of 2.5 ml at either L3-L4 or L4-L5 interspace. Perfusion index was monitored till the end of the operation. The following parameters were noted intraoperatively (Heart rate, SpO2, PI, blood pressure, and time to hypotension).

We defined hypotension as a decrease in blood pressure of 20% or more from baseline. During operation, those patients who developed hypotension were given Injection Phenylephrine 50 mcg IV bolus. Patients who developed hypotension were sorted as Group A, and those who did not develop hypotension were sorted as Group B.

All these findings were entered into the Statistical Program for Social Sciences version 25. Shapiro Wilk test was applied to see the normality of the variables. Mean and SD were calculated for continuous quantitative variables like age and PI. The percentage was calculated for the nominal variable hypotension. The student t test was applied to see the correlation of Perfusion Index and hypotension and vasopressor required. A ROC curve was obtained to see the sensitivity and specificity for PI and hypotension. A p-value less than 0.05 was considered significant.

Results

The mean age of the patients included in our study was 27.99±3.81 years. The distribution of women as per the PI group was comparable, as 49% women had PI <3.5% and 51% woman had PI >3.5%. Out of 300 patients, only 114 (38%) developed hypotension after spinal anesthesia and were included in group A (62%), while 185 did not develop hypotension and were included in group B. There was no statistically significant difference between age (p-value = 0.93), BMI (p-value = 0.11), and baseline systolic blood pressure between 2 groups. PI of Group A was 4.18 ± 1.33 Group B was 2.64 ± 0.93(p-value < 0.001) as shown in table 1.

Table 1: Clinical and Intraoperative Data in 2 Groups

	Group A (n=114)	Group B (n=186)	
	Mean ± SD	Mean ± SD	p-value
Age (years)	27.97 ± 4.29	28.01 ± 3.49	0.93
BMI (kg/m^2)	25.87 ± 2.16	26.3 ± 2.34	0.11
Baseline SBP (mmHg)	123.37 ± 8.61	121.45 ± 8.76	0.063
Baseline Perfusion Index	4.18 ± 1.33	2.64 ± 0.93	**<0.001**
Time_to_Hypotension	4.60 ± 1.74	---	---
Phenylephrine_Required	9.51 ± 2.69	00	**<0.001**

The Area Under the Curve (AUC) yielded as 3.5 optimal cutoff value with Sensitivity 79% and Specificity: 74%. 3.5 shows 0.84 (95% CI: 0.76–0.92) with an optimal cutoff value for PI: >3.5, having a sensitivity of 79% and Specificity of 74% as shown in Figure 1

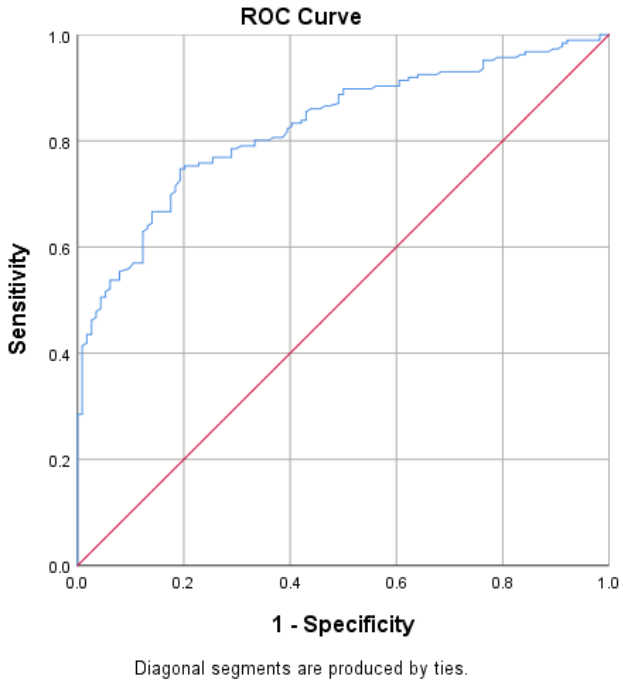

Figure 1: ROC curve analysis for the optimal Pulsatility Index (PI) cutoff value

Discussion

In our study, we could not find correlations between age, height, weight, and baseline heart rate with PI. Most researchers conclude that there is no role of age, height, and weight with PI; however, few reported that there is a role of obesity with PI.[12-14]

The mean baseline PI Index of the hypotension group was 4.2 ± 1.3, compared to 2.6 ± 0.9 in the non-hypotension group ($p < 0.001$), and ROC analysis revealed an area under the curve (AUC) of 0.84, indicating good diagnostic accuracy. The cutoff value of PI > 3.5 yielded a sensitivity of 79% and specificity of 74%. Our findings were consistent with Xu Z et al., who studied 90 pregnant patients and found that a higher baseline PI of more than 3.5 was associated with increased hypotension (47.8%) with p-value <0.05.[15] Similarly, Ahmed RA et al. also concluded with a positive relation between PI and hypotension, where they found a new cutoff value of 1.75 with a sensitivity of 75% and a specificity of 71%.[16]

Yokose et al., on the other hand, found no role of PI in predicting spinal hypotension and rather concluded that heart rate variability is more specific to the topic. We believe that this discrepant result could be because the author started hydroxyethyl starch infusion immediately after spinal injection and continued throughout delivery. Along with this rescue, epinephrine was given to patients if they felt dizzy, even if their blood pressure was above 80 mmHg.[17]

Interestingly, the time to hypotension was not significantly different between the two groups (4.60 ± 1.74 min in Group A vs. 4.92 ± 1.51 min in Group B, p = 0.1). This suggests that while PI predicts the likelihood of hypotension, it does not necessarily indicate an earlier onset.[18]

We used a cut-off PI of 3.5 as it is a better predictor than Harde et. & Toyama et al., lower values (PI=2.2) have been used by other authors.[7,11] These minor variations likely stem from differences in study populations or measurement techniques. However, the consistency across studies supports the robustness of PI > 3.5 as a reliable predictor.

Our study has a few limitations. Firstly, although pulse oximetry is subject to variation due to individual anxiety levels, patient movement, and discomfort because of increased sympathetic activity leading to peripheral vasoconstriction. Secondly, only the baseline PI was noted. We suggest that future researchers may investigate ongoing PI and compare it with baseline PI to predict hypotension.

Conclusions

Perfusion index is a simple, safe, rapid, and reliable method that can predict intraoperative hypotension through pulse oximetry at the fingertip. A high PI of >3.5 can be used as a cutoff to predict hypotension along with other methods.

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