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Role of Perfusion Index as a Predictor of Hypotension during Spinal Anaesthesia for Caesarean Section-A Prospective Study

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Abstract

Background: *Many attempts have been made to look for predictors of hypotension during spinal anaesthesia. Perfusion index (PI) obtained from pulse oximeter has been recently come into focus as predictor of hypotension during spinal anaesthesia for lower segment caesarean section (LSCS).*

Aims and Objectives: *To estimate the correlation between baseline perfusion index and incidence of hypotension following sub arachnoid block in LSCS.*

Materials and Methods: *In this prospective observational study, thirty parturients belonging to American society of Anesthesiologists (ASA) physical status 1 or 2 with uncomplicated pregnancies scheduled for elective caesarean section under spinal anaesthesia were included in the study. Spinal anaesthesia was performed with 2ml of 0.5% bupivacaine (hyperbaric) at L3-L4 or L2-L3 interspinous space using a 25G Quincke needle. Hypotension is defined as a decrease in systolic blood pressure (SBP) > 25% from baseline.*

Results: *The incidence of hypotension among study subjects was 66.7% There was significant correlation between baseline PI and fall in SAP from baseline ($r = 0.368$, $P < 0.05$).The optimal cutoff point across a range of cutoff points for PI was found to be 3.6 with a sensitivity of 80% and specificity of 60%,*

Conclusion: *Baseline perfusion index >3.6 is associated with a higher incidence of hypotension following spinal anaesthesia in elective LSCS.*

Introduction

Spinal anaesthesia has now emerged as the technique of choice among regional anaesthetic techniques for routine scheduled caesarean delivery.This is because it is fast, reliable and cost effective. The main adverse effect seen with spinal anaesthesia is the incidence of hypotension. Maternal hypotension can have serious adverse effect on neonatal and maternal outcome[1]. The incidence of hypotension in spinal anaesthesia has been reported to be 75-85%[2]. Hypotension happens as a result of fall in peripheral vascular resistance due to blockade of pre ganglionic sympathetic fibers which will be aggravated in pregnancy[3]. Pregnant women are more sensitive to local anaesthetics, less responsive to vasopressor[4]. Therefore parturients can develop profound hypotension following central neuraxial blockade for lower segment caesarean section (LSCS).

Many attempts have been made to look for predictors of hypotension in spinal anaesthesia. Some of the studied predictors are baseline heart rate[5], heart rate variability[6],body mass index[7], advanced age, pre operative anxiety[8] One novel predictor which has shown promise is the use of perfusion index (PI) derived from a pulse oximeter which effectively assesses peripheral perfusion dynamics and vascular tone[9] .PI is a relative assessment of the pulse strength at the monitoring site. It is derived from the plethysmographic waveform obtained from the pulse oximeter probe. PI is a numerical value that indicates the strength of the IR (infrared) signal returning from the monitoring site. It is calculated by the following formula[10]

Perfusion Index = $\frac{AC}{DC} X100$

AC represent the pulsating component of infrared signal, the light which is absorbed by the pulsating arterial inflow, it also represents the amplitude of pulse oximeter wave form. DC represents the non-pulsatile component of infrared signal that is absorbed by the skin, other tissues and non-pulsatile amount of blood at the vascular site.It is expressed as percentage

Hence, PI can be used to assess perfusion dynamics[10,11,12] PI has been used earlier for assessing haemodynamic parameters but there are limited data regarding its use for prediction of the incidence of hypotension occurring as a result of the central neuraxial blockade. We conducted this study to determine whether a baseline PI can predict the development of hypotension after spinal anaesthesia in parturients.

Materials and Methods

The prospective observational study was conducted from January 2016 to December 2016. Approval for the study was obtained from the Institutional Ethics Committee. Informed written consent was obtained from every participant in the study. Study design was prospective, double-blinded observational study.

Inclusion criteria

Pregnant women posted for elective caesarean section under spinal anaesthesia falling into American society of Anaesthesiologists Physical Status(ASA)[15] Class I or Class II. Baseline systolic blood pressure between 100-140 mmHg and diastolic blood pressure between 70-89 mmHg

Exclusion Criteria

Parturients with placenta praevia, preeclampsia, cardiovascular or cerebrovascular disease, gestational diabetes, ASA class III or IV, body mass index ≥30, gestational age <36 or >41 weeks, multiple pregnancy disorders of Autonomic nervous system, contraindications to spinal anaesthesia were excluded

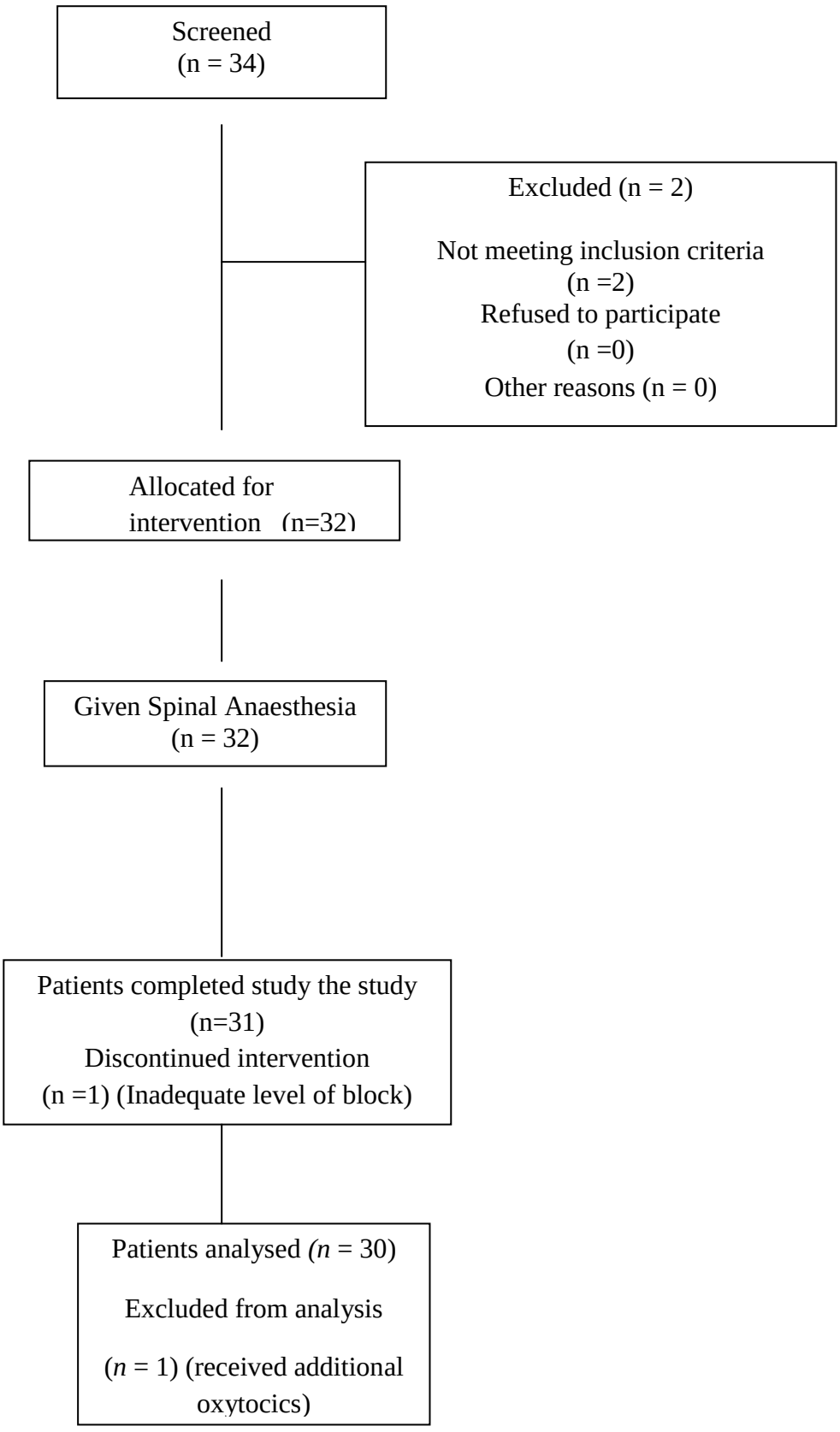
Anesthetic technique

Standard monitoring with electrocardiography, automated non invasive blood pressure (NIBP) and pulse oximetry (SpO_2) was performed for baseline values and intraoperative monitoring using Philips MP 20 monitor (Philips Electronics Tokyo, Japan). The perfusion index was measured in the supine position using a specific pulse oximeter probe (Masimo Radical 7®; Masimo Corp., Irvine, CUSA) which was attached to the left index finger of all parturients. The baseline

haemodynamic values were recorded in the supine position by an anaesthesiologist who was not involved in the further intraoperative monitoring of the patient. Intravenous (IV) access was established in the left upper limb. Each parturient was prehydrated with 500 ml of Ringer lactate over 20 min. After pre hydration ringer lactate solution was transfused till the end of the surgery at a total dose of 20ml/Kg of body weight. Foetal heart rate was monitored till the cleaning and draping of the patient. Spinal anaesthesia was performed by an anaesthesiologist blinded to the baseline PI values, using Quincke's 25‑gauge spinal needle in left lateral decubitus position with 2ml of injection bupivacaine 0.5% (hyperbaric) at the L3–L4 or L2–L3 interspace. The parturient was returned to the supine position with a left lateral tilt of 15° to facilitate left uterine displacement. Oxygen was given through face mask at 3 L/min. The level of sensory block was checked 5 min after the spinal injection with a cold swab. If a T6 sensory block level was not achieved, these parturients were excluded from the study and managed according to institutional protocol. Maximum cephalad spread was checked 20 min after sub arachnoid block (SAB). Systolic blood pressure (SBP), Diastolic blood pressure (DBP),Mean arterial pressure(MAP), Heart rate (HR), respiratory rate (RR), SpO2 and PI were recorded at 1 min intervals after the SAB up to 10 min and then at 3 min intervals by the same anaesthesiologist who administered SAB till the end of surgery. Hypotension was defined as a decrease in SBP > 25% from baseline and treated with IV bolus of 3 mg injection of mephenteramine and 100 ml of Ringer lactate. Bradycardia was defined as HR <60 beats/min and treated with injection atropine 0.6 mg IV bolus. Following extraction of the baby, Apgar score was recorded at 1st and 5th min. Injection oxytocin 10 units was given as uterotonic following baby extraction at a rate of 200 mU/min as a separate infusion. Patients requiring additional oxytocics and/or additional surgical interventions excluded from the study, patients with intraoperative blood loss greater than 1000ml were excluded The incidence of other side effects such as nausea, vomiting if observed were recorded. Categorical and discrete data are presented as tables, and continuous data represented by graphs. Independent sample t test was applied for parametric variables and Mann Whitney U test was used for non parametric variables. Regression analysis with Karl Pearson correlation method was done to assess the correlation between baseline PI with other parameters. A Receiver Operating Characteristic (ROC) curve was obtained for baseline PI compared with the hypotension episodes of 30 patients. Data were analysed using SPSS (Statistical Package for Social Sciences) version 20.*P* <0.05 was considered statistically significant.

A total of 34 patients were included in the study. Two parturients were excluded from the study according to the exclusion criteria,one parturient developed inadequate level of the spinal blockade, and one parturient had to be excluded due to the requirement of additional oxytocics, as the drugs administered could influence the HR and blood pressure of the patients. A total of 30 subjects were analysed.

Figure 1: CONSORT Flow Diagram



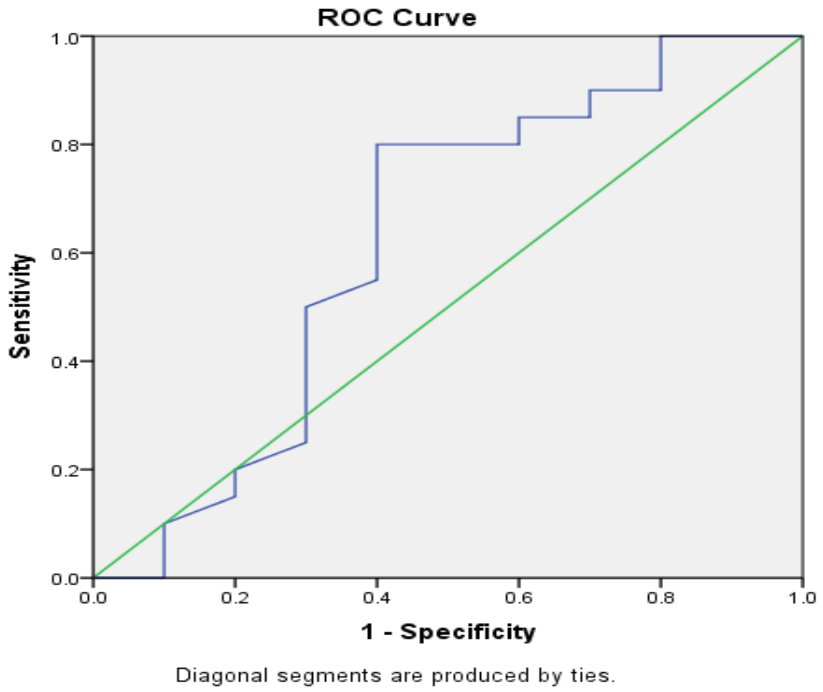
Results

Table 1: Patient characteristics

Parameter(n=30)	Mean	Std. Deviation
Age	27.20	4.10
Height	157.60	3.66
Weight	64.87	6.26
BMI*	26.23	1.69
Gestational Age	38.57	0.68

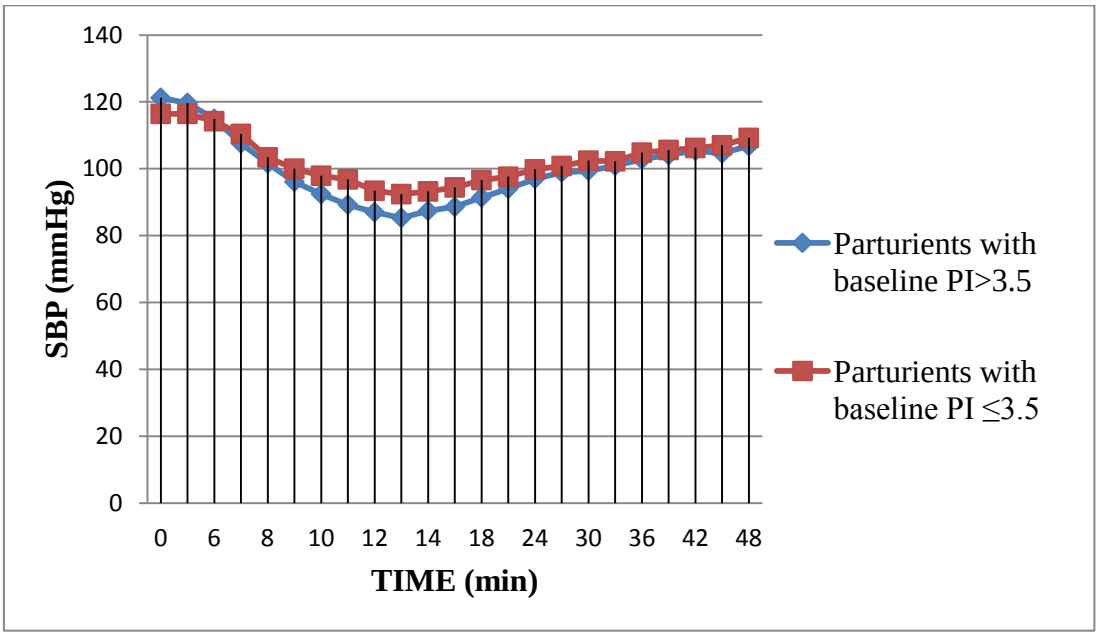
*BMI-Body Mass Index

Figure 2: ROC* curve depicting baseline PI †, against incidence of hypotension



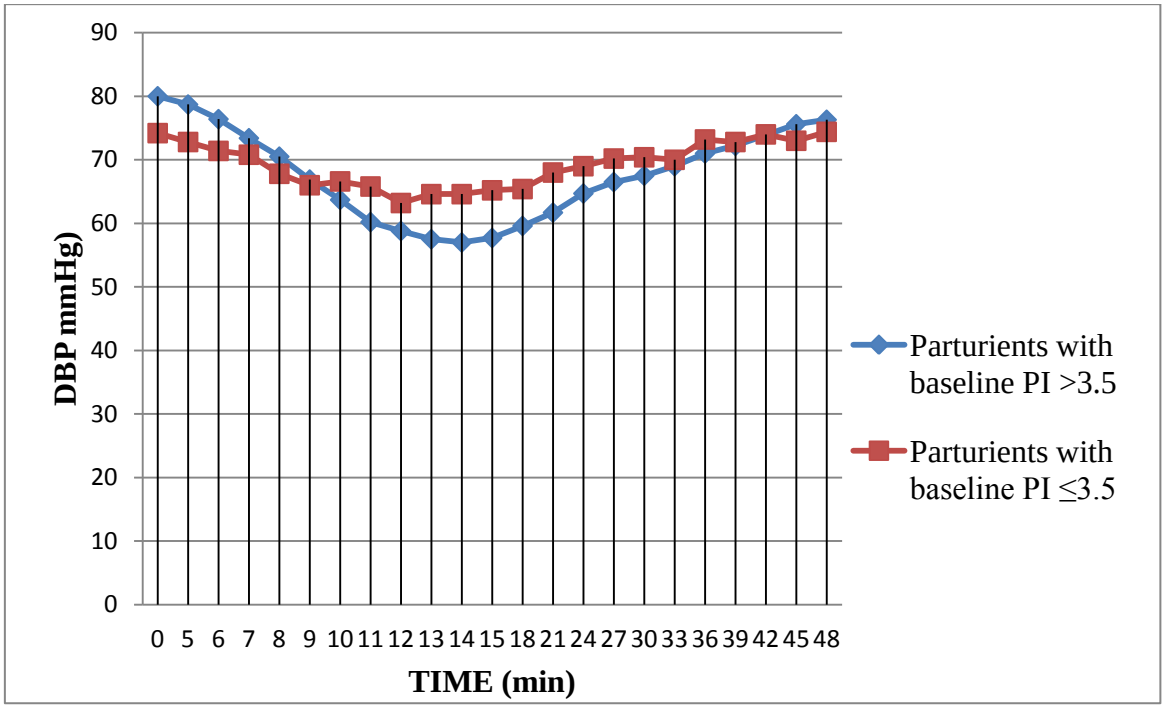
*ROC-Receiver operating curve
† PI-Perfusion index

Figure 3: Changes in SBP* after spinal anaesthesia in both groups



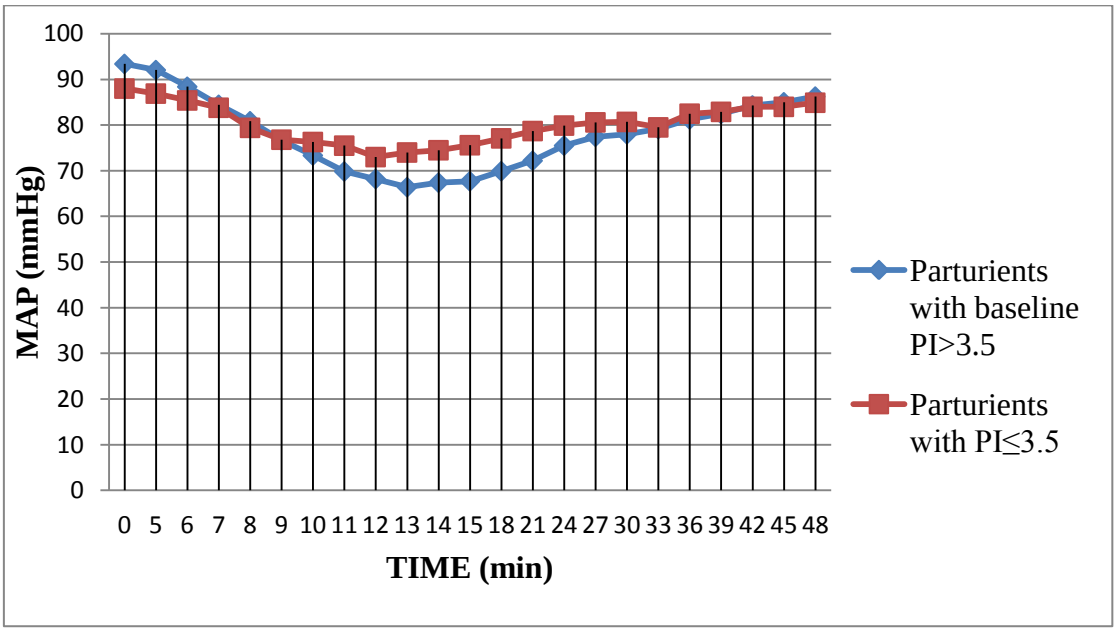
*SBP-Systolic blood pressure

Figure 4: Changes in DBP* after spinal anaesthesia in both groups



*DBP-Diastolic blood pressure

Figure 5: Changes in MAP* after spinal anaesthesia in both groups



*MAP-Mean arterial blood pressure

Discussion

It is a well known fact that sub arachnoid block is the most common method of administering anaesthesia in lower segment caesarean section. The most common complication of sub arachnoid block is hypotension.

The present study incidence and severity of hypotension, was higher in parturients whose baseline PI values were greater than 3.6. The ROC curve revealed that PI discriminated well between patients who developed hypotension versus those who did not; it yielded a new baseline PI value of 3.6 as the cut off point for predicting hypotension in parturients undergoing caesarean section under sub arachnoid block with a sensitivity of 80% and specificity of 40%The most side effect of spinal anaesthesia is hypotension[13]

Many haemodynamic parameters have been studied as predictors of hypotension Some studies have been done predicting hypotension following spinal anaesthesia in casearean section.[14] The principle of the pulse oximetry is the difference in absorbance of light with different wavelengths 660nm (Red) and 940 nm (Infrared) by deoxygenated and oxygenated haemoglobin respectively. Perfusion Index, or PI, is a relative assessment of the pulse strength at the monitoring site. It is derived from the plethysmographic waveform derived from the pulse oximeter probe. Perfusion Index is a numerical value that indicates the strength of the IR (infrared) signal returning from the monitoring site [15]

AC represent the pulsating component of infrared signal, the light which is absorbed by the pulsating arterial inflow, it also represents the amplitude of pulse oximeter wave form. DC represents the non-pulsatile component of infrared signal that is absorbed by the skin, other tissues and non-pulsatile amount of blood at the vascular site. It is expressed as percentage.

Physiological change in pregnancy is the decrease in systemic vascular resistance along with increase in cardiac output[16]. Fall in the resting tone will lead to vasodilatation and rise in the pulsatile component of perfusion index and cause a rise in values. The sympathectomy as a result of spinal anaesthesia will cause further loss of peripheral vascular tone and increased pooling of blood in extremities leading to hypotension. Increase in tone will correspond to higher perfusion index values due to increase in pulsatile component of perfusion index .Parturients with high baseline perfusion index are expected to have lower peripheral vascular tone and hence are at higher risk of developing hypotension following spinal anaesthesia. PI has been used in the study by Mowafi *et al*[10] showed that perfusion index was able to detect sympathetic blockade following epidural anaesthesia using 2% lignocaine with adrenaline. Ginosar*et al*.[11] PI was an earlier, clearer and more sensitive indicator of the development of epidural-induced sympathectomy than either skin temperature or MAP. In contrast, a recent study performed by Yokose *et al*.[17] demonstrated that PI had no predictive value for hypotension in parturients undergoing LSCS following SAB. This discrepancy was attributed to various methodological differences, such as the definition of hypotension, co-loading with colloids and method of calculation of baseline PI. A study done by Toyama *et al*[14] on 35 parturients studied the correlation baseline perfusion index and hypotension. Results of their study showed a positive correlation ROC curve with AUC =0.87. In this study we have studied the predictive ability of perfusion index in Indian population.

In this study, the baseline PI >3.6 and probability of hypotension were significantly correlating, a finding similar to study by Toyama *et al*. On Karl Pearson correlation, a highly significant correlation was found between baseline PI >3.6 and hypotension. Toyama *et al*. found a sensitivity and specificity of 81% and 86%, respectively, for baseline PI with a cut-off of 3.5 to predict hypotension, whereas in this study, for baseline PI with a cut off of 3.6 the specificity was, 80%, but sensitivity was lower, 40%.

In this study, spinal anaesthesia was used to achieve a block level of T6 whereas spinal epidural technique was used in the study by Toyama *et al*. We used injection mepheteramine to treat hypotension while they used only injection phenylephrine to treat hypotension.

There are many limitations in this study. In this study we have compared perfusion index with non invasive blood pressure which can measure blood pressure only with a time lag. Ideally perfusion index should have been compared with invasive arterial blood pressure. However arterial cannulation was inappropriate in this study since it was elective caesarean section Baseline Perfusion index, heart rate blood pressure were taken with patient in supine position but after administering spinal anaesthesia a left tilt was given. This will reduce aortocaval compression and this may interfere with results. Patient anxiety, temperature at the measuring site can also affect the

measurements. Patient movement can also affect the probe position and give false results. In this study, we recorded baseline PI values with utmost care to avoid patient movement, especially while recording baseline values and all patients were counseled before taking them up for surgery to allay anxiety. The baseline value of PI could have been affected due to aortocaval compression in supine position while recording baseline values. Systemic vascular resistance was not measured, but it would be invasive and unnecessary for the uncomplicated caesarean section.

Since PI is dependent on the vascular tone of digital vessels, its role in predicting hypotension in conditions where the tone of these vessels is affected is questionable and more studies regarding its use in other patients needs to be done before it can be accepted as a universal non‑invasive tool to predict hypotension following spinal anaesthesia. In addition, further studies comparing PI with invasive methods of haemodynamic monitoring may shed more light regarding its utility.

Conclusion

Perfusion Index (PI) can be used as a predictor of hypotension in healthy parturients undergoing elective caesarean section under SAB. Parturient with baseline PI >3.6 are at higher risk of developing hypotension following SAB compared to those with baseline PI ≤3.6.

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