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An observational study on perfusion index to predict and correlate incidences of hypotension following spinal anaesthesia using pulse oximeter

Dr. Pooja Shah
Associate Professor, Department of Emergency Medicine, SBKS MI and RC, Piparia, Vadodara, Gujarat, India

Dr. Ria Ganguly
Senior Resident, Department of Community Medicine, PIMSR, Parul University, Limda, Vadodara, Gujarat, India

Dr. Lokesh Kumar Jain
PG resident, Department of Anaesthesiology, SBKS MI and RC, Piparia, Vadodara, Gujarat, India

Dr. Kamlesh Patel
Assistant Professor, Department of Orthopedics, GMERS Medical College & Hospital, Himatnagar, Sabarkantha, Gujarat

Dr. Kirti Patel
Professor, Department of Anaesthesiology, SBKS MI and RC, Piparia, Vadodara, Gujarat, India

Dr. Dinesh Chauhan
Professor and Head, Department of Anaesthesiology, SBKS MI and RC, Piparia, Vadodara, Gujarat, India

***Abstract*---**Perfusion Index (PI) is the ratio of the pulsatile blood flow to the non-pulsatile or static blood in the peripheral tissues. It is a new parameter tried for predicting hypotension during spinal anaesthesia. Our aim was to observe Perfusion Index as an early predictor of hypotension under spinal anaesthesia in patients undergoing elective surgeries. In this observational study, 30 patients between the age group of 18-50years and belonged to ASA I and II category were taken. Spinal anaesthesia was performed with 3-4 ml of injection Bupivacaine 0.5% (hyperbaric) at L3–L4 interspace.

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***Corresponding author**: Jain, L. K.; Email: lokesh.dr.jain@gmail.com*
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Following spinal anaesthesia heart rate, blood pressure, and PI were recorded for 30 minutes. Hypotension was defined as fall in the MAP of 20% from the baseline and was treated with fluids, parasympatholytic ± vasopressors. Analysis was performed using software IBM SPSS statistics for windows, Data was presented as mean ± standard deviation. A P value < 0.05 was considered statistically significant. Regression analysis with Spearman's rank correlation coefficient was done to assess the correlation between baseline PI and hypotension. Receiver operating characteristic (ROC) curve was plotted for PI and occurrence of hypotension. There was fall in MAP after spinal anaesthesia and among them it was significantly correlated with rise in PI value at 10 and 15 minutes after SAB (P< 0.05). It was concluded that perfusion index has correlation with hemodynamic changes during neuraxial blockage. It can be used as a predictor of hypotension under spinal anaesthesia.

***Keywords*---**perfusion index, sub arachnoid block, hypotension.

Introduction

Pulse oximeter was developed by Takuo Aoyagiand and Michio in 1992[1]. In 1995, Masimo introduced Perfusion Index, quantifying the amplitude of the peripheral plethysmograph waveform. Perfusion index (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 [2]. Pulse oximeter has two wavelengths of 660 nm and 940 nm. Absorbance of light in both Wave lengths has a pulsatile and non pulsatile component. Pulsatile component represents the fluctuation in the volume of arterial blood between the source and the detector in the pulse oximeter. The non-pulsatile component is from the venous flow, bone and connective tissue[1]. Hence, PI can be used to assess peripheral perfusion dynamics due to changes in peripheral vascular tone and is being considered as a non-invasive method to detect the likelihood of development of hypotension following spinal anaesthesia[3,4,5].

Normal range is from 0.02% (very feeble pulse strength) to 20% (very strong pulse strength). Spinal anesthesia is the technique of choice over general anaesthesia because it avoids the risk of failed intubation and its consequences, but also because it provides more effective pain control, early ambulation, hence fast return to daily activities for the patients thereby increasing their quality of life. The only concern of spinal anaesthesia is occurrence of hypotension, which is managed by administration of fluids and occasionally use of vasopressors. This study was aimed to predict and correlate perfusion index with incidences of hypotension and MAP following spinal anaesthesia using a pulse oximeter.

Material and Methods

This Observational study was conducted in tertiary care centre. Approval was obtained from the Institutional Ethics Committee for the study. All the patients

participating in the study were explained clearly about the purpose and nature of the study in the language they can understand. They were included in the study only after obtaining a written informed consent. We had enrolled 30 patients for the study.

Patients with systemic disease like heart disease, liver disease, kidney disease, Hemoglobin (<8g/dl), shock, septicemia, coagulation disorders or on anticoagulant therapy, local infection, spinal deformities, history of pre operative blood transfusion and intra operative blood transfusion, allergy to drug and PI value <0.2 and >10 were excluded. Thirty patients between age group of 18-50 years posted for spinal anaesthesia for various surgeries were included in our study and patients who refused to give consent were excluded. Each patient was preloaded with 500 ml of Ringer lactate over 20 min. Standard monitoring with electrocardiography (ECG), NIBP, and pulse oximetry (SpO2) was performed for baseline values and intraoperative monitoring. The perfusion index was measured in the supine position using a specific pulse oximeter probe (Masimo Radical 7®; Masimo Corp., Irvine, CA, USA) which was attached to the right index finger of all patients to ensure uniformity in measured PI values. This was an observational study. The baseline haemodynamic values including PI were recorded in the supine position by an anaesthesiologist who was not involved in the further intraoperative monitoring of the patient. While administering neuraxial blockade, the Masimo® pulse oximeter was disconnected to prevent observer bias and SpO2, Pulse were recorded using a different pulse oximeter.

Spinal anaesthesia was performed by an anaesthesiologist blinded to the baseline PI values, using Quincke's 25 gauge spinal needle in sitting position with 15 mg to 20mg of injection bupivacaine 0.5% 3-4ml (hyperbaric) at the L3–L4 interspace. The patient was returned to the supine position. The Masimo® pulse oximeter was reconnected to monitor the patient till the end of surgery. Ringer's lactate was administered at a rate of 100 ml/10 min. NIBP, heart rate (HR), SpO2, level of spinal anaesthesia and PI were recorded at 5 min intervals after the SAB up to 30 min. Rate pressure product is a measure of the stress put on the cardiac muscle based on the number of times it needs to beat per minute (HR) and the arterial blood pressure that it is pumping against (SBP). RPP = HR × SBP. We had also checked correlations between PI and Rate pressure product (RPP).
Bradycardia was defined as pulse rate < 60/min and treated with IV Atropine sulfate 0.6mg stat. Hypotension was defined as fall in the MAP of 20% from the baseline and was treated with fluids, parasympatholytics ± vasopressors.

The first 20 min following spinal anaesthesia was considered for anaesthesia–induced hypotension. The incidence of other side effects such as nausea, vomiting if observed were recorded and treated accordingly. Analysis was performed using software IBM SPSS statistics for windows, Data was presented as mean ± standard deviation. $P < 0.05$ was considered statistically significant. $P < 0.001$ was considered as statistically highly significant and $P > 0.05$ was as statistically not significant. Regression analysis with Spearman's rank correlation coefficient was done to assess the correlation between baseline PI and hypotension. Receiver operating characteristic (ROC) curve was plotted for PI and occurrence of hypotension. Categorical and discrete data were presented as tables, and continuous data represented by graphs.

Results

30 Patients with ASA I and II posted under spinal anaesthesia were observed. Data was presented as mean (range) in the table given below (n=30).

Table 1
Demographic data

Age (years)	41 (18-50) mean
Weight	58 kg mean
Male	21
Female	09
ASA I	04
ASA II	26

Table 2
Perfusion Index before and after spinal anaesthesia

Time (Minutes)	Mean PI	Std. Deviation	P value comparing with baseline
Baseline PI	1.67	0.894	
0	1.55	0.821	0.052
5	1.67	0.97	0.975
10	1.81	1.321	0.547
15	1.89	1.529	0.436
20	1.88	1.142	0.325
25	1.78	1.221	0.621
30	1.95	1.4	0.271

Above data showed that there was no significant change (P>0.05) in PI values before and after SAB.

Table 3
Comparison of PI values and Heart rate (HR)

Time (Minutes)	PI (mean)	PI (SD)	HR(Mean)	HR(SD)	Correlation Coefficient (r)	P value
Baseline	1.67	0.894	88.9	13.168	-0.189	0.318
0	1.55	0.821	87.53	12.145	-0.196	0.298
5	1.67	0.97	87.47	11.482	0.151	0.425
10	1.81	1.321	85.03	11.592	0.004	0.983
15	1.89	1.529	82.63	10.166	-0.238	0.206
20	1.88	1.142	83.1	10.516	-0.210	0.266
25	1.78	1.221	82.07	9.892	0.024	0.898
30	1.95	1.4	84.5	11.814	0.106	0.577

Our study showed that there was fall in mean HR upto 25 minutes after spinal anaesthesia but there was no significant correlation (P > 0.05) between perfusion index and heart rate at different time interval. One patient in our study developed bradycardia which was treated with inj. Atropine 0.6 mg intravenously.

Table 4
Comparison of PI values and Mean blood pressure (MAP)

Time (Minutes)	PI (mean)	PI (SD)	MAP(Mean)	MAP(SD)	Correlation Coefficient (r)	P value
Baseline	1.67	0.894	99.03	9.129	0.015	0.93
0	1.55	0.821	95.53	9.07	-0.075	0.69
5	1.67	0.97	89.53	8.955	-0.125	0.51
10	1.81	1.321	86	9.388	-0.458	0.011(s)
15	1.89	1.529	83.1	9.813	-0.514	0.004(s)
20	1.88	1.142	83.83	9.248	-0.297	0.11
25	1.78	1.221	84.17	9.805	0.001	0.99
30	1.95	1.4	82.93	9.044	0.184	0.33

Above data showed that there was significant change (P<0.05) in mean blood pressure and PI value at 10 and 15 minutes after SAB. This means MAP decreases with increase in PI value at that time interval.

Table 5
Comparison of PI and RPP (rate pressure product)

Time (Minutes)	PI (mean)	PI (SD)	RPP(Mean)	RPP(SD)	Correlation Coefficient (r)	P value
Baseline	1.67	0.894	11615.7	2042.3	-0.117	0.537
0	1.55	0.821	10887.6	1749.9	-0.178	0.348
5	1.67	0.97	10272.5	1585.4	0.088	0.643
10	1.81	1.321	9796.8	1920.4	-0.167	0.378
15	1.89	1.529	8982.2	1537.8	-0.330	0.075
20	1.88	1.142	9099.5	1547.9	-0.205	0.276
25	1.78	1.221	9003.7	1612.5	0.038	0.842
30	1.95	1.4	9151.4	1764.9	0.250	0.183

There was no significant change (P> 0.05) in perfusion index and rate pressure product after SAB with different time interval.

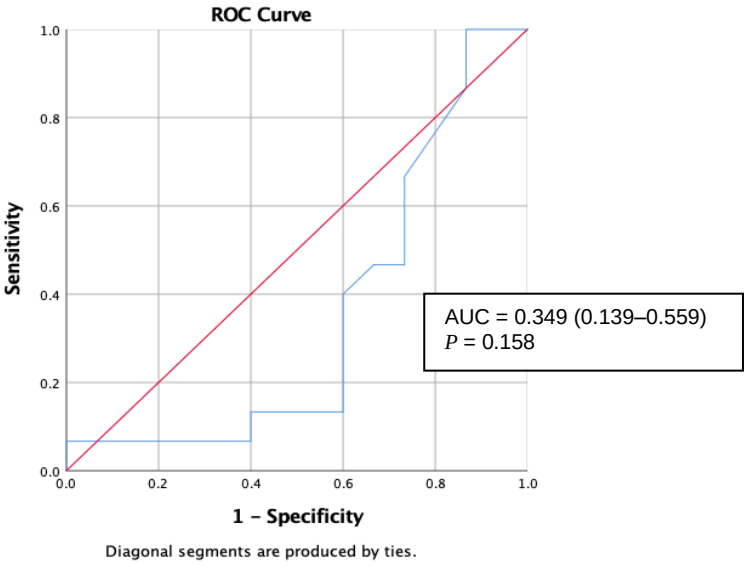

Fig 1. ROC curve depicting baseline PI against incidence of hypotension

Area Under the Curve(AUC)				
Test Result Variable(s)				
Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
0.349	0.107	0.158	0.139	0.559

The AUC is an overall summary of diagnostic accuracy. AUC equals 0.5 when the ROC curve corresponds to random chance and 1.0 for perfect accuracy. On rare occasions, the estimated AUC is <0.5, indicating that the test does worse than chance. Since AUC is <0.5, there is less than random chance of PI being able to predict hypotension. However in our study we found significant correlation between fall in MAP with rise in PI value at 10 and 15 minutes.

Discussion

In our study we have observed HR, MAP, RPP at different time interval after giving sub arachnoid block. All the patients in our study had baseline PI value < 3.0. Most of our patients (80%) had achieved T10 level at the end of 20 minutes. We found fall in mean HR upto 25 minutes after spinal anaesthesia but there was no significant correlation (P > 0.05) between perfusion index and heart rate at different time interval. Only one patient observed bradycardia which was treated with inj Atropine 0.6 mg intravenously. We observed significant decrease in mean blood pressure at 10 minutes (P-0.011) and 15 minutes (P- 0.004) after spinal anaesthesia which was correlated with increase in perfusion index(P<0.05).

Manish et al also observed correlation between PI and hemodynamics. They found that perfusion index in toe increases continuously from baseline at various

intervals, there was simultaneous drop in mean blood pressure [6]. Similar results were found in our study. Toyama at el demonstrated that higher baseline PI was associated with profound hypotension and that baseline PI could predict the incidence of spinal anaesthesia induced hypotension during Caesarean delivery [7]. In contrast to that Bharat shah and his colleagues also aimed at investigating the correlation between baseline perfusion index (PI) and incidence of hypotension following SA for parturients undergoing LSCS [8]. They found no significant correlation between baseline PI (>3.5 and ≤3.5) and incidence and severity of hypotension ($p > 0.05$). Duggappa and his friends also showed that Perfusion Index (PI) can be used as a tool for predicting hypotension in healthy parturients undergoing elective caesarean section under SAB [9].

Many studies on perfusion index had been carried out on parturients posted for LSCS under spinal anaesthesia. We wanted to find similar correlation between PI and hypotension in all the patients under spinal anaesthesia. We found that there was fall in heart rate immediately after SAB which was not significantly associated with rise in PI value. The initial tachycardia could be attributed to the anxiety regarding the procedure with the heart rate settling gradually. In our study fall in MAP was observed after spinal anaesthesia at different time intervals. And among them it was significantly correlated with rise in PI value at 10 and 15 minutes after SAB ($P< 0.05$).

Hyuga at el showed that PI at the toe changes quickly in response to vasodilation after spinal anesthesia, whereas PI at the site of finger and groin remains constant. The results suggest that PI was useful for evaluating the circulatory state after spinal anesthesia [10]. We evaluated changes in PI value in upper limb with spinal anaesthesia. The area under the curve (AUC) is indicating summary of diagnostic accuracy of the used tool [11]. When AUC equals 0.5, it corresponds to random chance and for detecting perfect accuracy AUC should be 1.0. Our AUC was 0.349, which was less than 0.5, so ROC analysis showed less sensitivity and specificity with the baseline PI for prediction of spinal anaesthesia-induced hypotension in the patients undergoing surgeries other than LSCS.
None of our patients had observed hypotension, nausea, vomiting after spinal anaesthesia.

Conclusion

Perfusion index has some negative correlation with the mean arterial pressure and it can be used for predicting and correlating the hemodynamic responses to subarachnoid block.

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Conflicts of interest: Nil

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