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Original Research Article

Assess the Correlation between Baseline Perfusion Index and Incidence of Hypotension Following Spinal Anaesthesia

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Abstract

Objective: This study is aimed to assess the correlation between baseline Perfusion index and incidence of hypotension following spinal anaesthesia. To observe if intra-operative changes in PI values correlate with degree of hypotension during spinal anaesthesia.

Methods: Patients posted for elective surgery under spinal anaesthesia (21 to 60 years of age) were included for our study. Patients with a baseline perfusion index of less than 3.5 were included in Group A whereas group B was formed by patients with a baseline perfusion index of 3.5 or more. So, our study population group was different from our reference studies that were conducted in obstetric population.

Results: Majority of the cases belonged to the age group of 41 to 50 years in both groups and were comparable to each other (p value=0.234). Male: female ratio was comparable in the two groups (p value=0.482).It was found that 25 incidences of hypotension (MAP<65mmHg) were recorded after subarachnoid block amongst 165 patients in group A (baseline PI<3.5), whereas other 165 patients in group B with a baseline PI more than or equal to 3.5 recorded 23 incidences of hypotension after spinal anaesthesia, evident from table 9. No significant difference was noted in the two groups with respect to number of incidences of hypotension (MAP<65mm Hg) following spinal anaesthesia (p value = 0.628).

Conclusion: Baseline perfusion index cannot predict the incidence of profound hypotension following spinal anaesthesia. Trends of fall in perfusion index after spinal anaesthesia was observed with decreasing, systolic, diastolic and mean blood pressures but, perfusion index is not a reliable parameter to indicate changes in blood pressure.

Keywords: Baseline Perfusion Index, Profound Hypotension, Spinal Anaesthesia

Introduction

Spinal anaesthesia has a wide range of application for orthopaedic, obstetric, gynaecological and general surgeries where single injection of local anaesthetic drug into sub-arachnoid space produces rapid and profound sensory blockade, motor blockade and sympathetic blockade. Hypotension is a

very common side effect seen following spinal anesthesia. [1]

Non-invasive blood pressure is the standard for assessing hypotension intra-operatively, but non-invasive methods measure blood pressure intermittently. Continuous blood pressure monitoring is possible only through invasive method which is achieved by arterial cannulation and pressure transduction. Invasive arterial blood pressure monitoring is indicated for anticipated profound hypotension, wide blood pressure deviations, end organ damage and need for multiple ABG measurements. [2]

To reduce the incidence of complications due to intra-operative hypotension we need to study new, non-invasive, cost effective, fast and simple to use tools to assess intra operative hypotension in advance. Assessment of intra operative hypotension in advance will help us to take effective measures to prevent it rather than treating intra operative hypotension. [3] This will result in better clinical outcome for patients post operatively. Continuous variations in blood pressure cannot be determined by non-invasive methods of blood pressure measurement. So we need a parameter that can be monitored continuously to indicate momentary variations in perfusion dynamics. [4,5]

PERFUSION INDEX (PI) is a new hemodynamic parameter that has been used to assess peripheral perfusion status of the patients. It is defined as the ratio of pulsatile blood flow to non-pulsatile blood flow in peripheral vascular tissues, measured using pulse oximeter based on the amount of infrared light absorbed. [6]

Perfusion index is numerical value of the amplitude of the plethysmograph that is displayed on pulse oximeter monitor. Pulse oximetry is done using a variable amount of light is absorbed by pulsating arterial flow (AC) and a constant amount of light is absorbed by non-pulsating blood and tissue (DC). The pulsating signal (AC) compared to non-pulsating signal(DC) and expressed as ratio is commonly referred to as the "perfusion index" = AC × 100/DC%. [7]

We conducted this study with the aim to determine if a baseline perfusion index of more than 3.5 could predict the incidence of hypotension (MAP>=3.5), so that we may prepare well in advance to prevent incidence of hypotension (MAP<65mmHg). [8,9]

Materials and Methods

Study Design: This is a single center, prospective observational study

Study Duration: 18 months from December 2020 to May 2021

Study Groups: 330 patients were enrolled for this prospective observational study initially which yielded 175 patients with a baseline perfusion index less than 3.5, First 165 out of these 175 were considered as group A with baseline PI<3.5 Twenty patients were additionally included in the study which yielded a sample of total 165 patients with a baseline PI >= 3.5 i.e. group B.

Group A- 165 patients who underwent surgical procedure under spinal anaesthesia with a baseline PI < 3.5

Group B -165 patients who underwent surgical procedure under spinal anaesthesia with a baseline PI of 3.5 or more

Inclusion Criteria:

1. Patients giving valid consent for spinal anaesthesia.
2. Adult patients between 18-60 years
3. Patients with ASA I and ASA II physical status
4. Scheduled for elective surgeries under spinal anaesthesia with sensory block level T6-T8

Exclusion Criteria:

1. Patient's refusal to spinal anaesthesia
2. Patients with ASA physical status III, IV, V, VI & parturients.
3. History of allergy to local anaesthetic.

4. Patchy / inadequate analgesia with sensory block level higher than T6 or lower than T8
5. Patients with coagulation abnormalities.
6. Patients with compromised cardio-pulmonary profile

Informed Consent: A consent form was made in two languages, English and hindi (vernacular language). Prescribed guidelines for research on human participants were followed and the consent form was sent to the institutional ethics committee. Before participation into the study each participant was explained about the procedure of spinal anaesthesia and the consent form was well explained in vernacular language. Participants who were willing to take participation in study were asked to sign the consent form.

Data Collection: Data was collected in a collection form as per annexure-II. This was a double blinded study, so baseline values were recorded by the anaesthesia personnel who was not a part of the study and further intraoperative monitoring. Procedure of subarachnoid block (SAB) and further monitoring was done by other anaesthesiologist.

Procedure

Perfusion index was monitored using Philips pulse oximeter probe which was attached to left index finger. This was a double blinded study, so baseline values were recorded by an experienced anaesthesia personnel who was not a part of the study and further intraoperative monitoring. Side effects such as nausea and vomiting were noted.

Observation Chart

A total of 330 patients were included for the study equally divided into two groups based on baseline perfusion index.

Table 1: Age distribution between groups

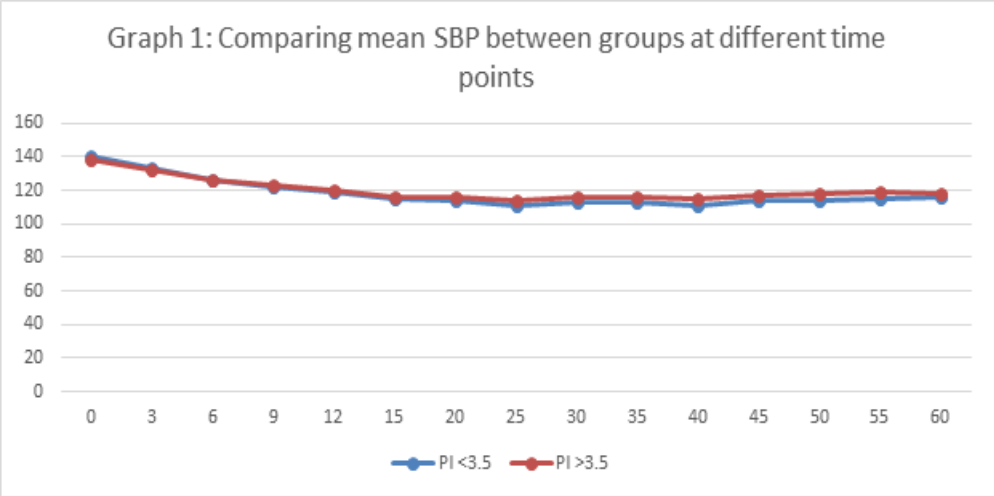
			Groups		Total	P value
			Group A PI <3.5	Group B PI >=3.5		
Age group (years)	21-30	N	44	36	80	0.234
		%	26.7%	21.8%	24.2%	
	31-40	N	45	41	86	
		%	27.3%	24.8%	26.0%	
	41-50	N	50	51	101	
		%	30.3%	30.9%	30.6%	
	51-60	N	26	37	63	
		%	15.8%	22.4%	19%	
Total		N	165	165	330	
		%	100.0%	100.0%	100.0%	

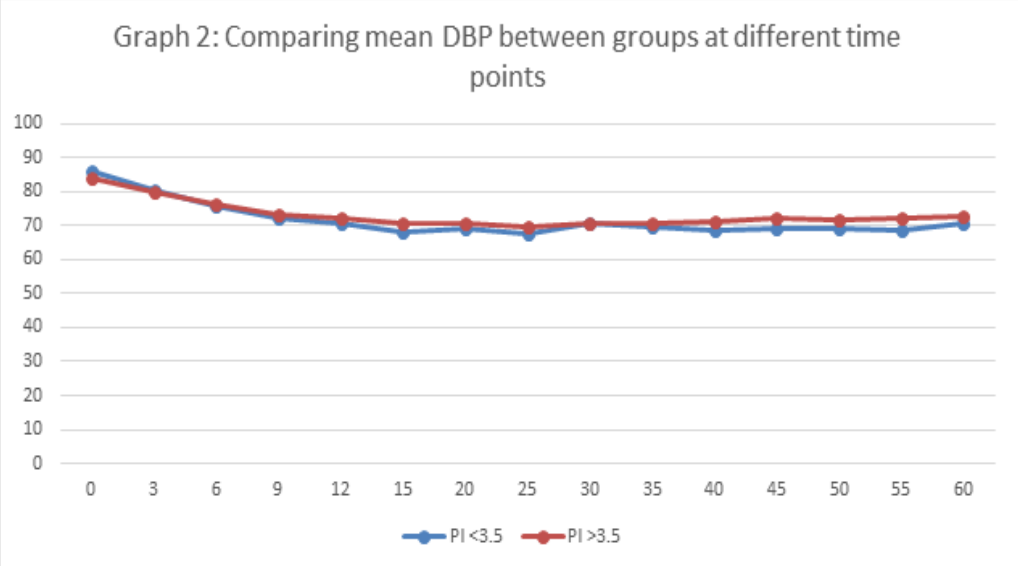
Table 2: Sex distribution between groups

			Groups		Total	P value
			Group A PI <3.5	Group B PI >=3.5		
SEX	Female	N	61	58	119	0.482
		%	36.9%	35.2%	36%	
	Male	N	104	107	211	
		%	63.1%	64.8%	64%	
Total		N	165	165	330	
		%	100.0%	100.0%	100.0%	

Table 3: Comparing mean PI between groups at different time points

Time points (min)	Groups						P value
	Group A PI <3.5		Group B PI >=3.5		Total		
	Mean	SD	Mean	SD	Mean	SD	
0	1.693	0.8072	4.113	0.6325	2.903	1.4119	<0.001
3	1.6963	0.89346	2.7612	0.92113	2.2288	1.05131	<0.001
6	1.370	0.6456	2.137	0.9264	1.753	0.8850	<0.001
9	1.355	0.7071	1.676	0.8104	1.515	0.7763	<0.001
12	1.219	0.7470	1.521	0.7761	1.370	0.7753	<0.001
15	1.2819	1.03748	1.4498	0.84837	1.3658	0.94994	0.109
20	1.0057	0.52839	1.3480	0.82664	1.1768	0.71357	<0.001
25	0.9831	0.50112	1.3247	0.81435	1.1539	0.69643	<0.001
30	0.9477	0.44047	1.2313	0.71866	1.0895	0.61182	<0.001
35	1.0238	0.55464	1.2282	0.73738	1.1260	0.65945	0.005
40	1.1261	0.98134	1.2996	0.88621	1.2128	0.93760	0.093
45	1.0742	0.68773	1.2916	0.81278	1.1829	0.75955	0.009
50	1.0327	0.54852	1.2595	0.71456	1.1461	0.64606	0.001
55	1.0201	0.51914	1.2507	0.70480	1.1354	0.62872	0.001
60	0.9562	0.40067	1.2584	0.69773	1.1073	0.58788	<0.01





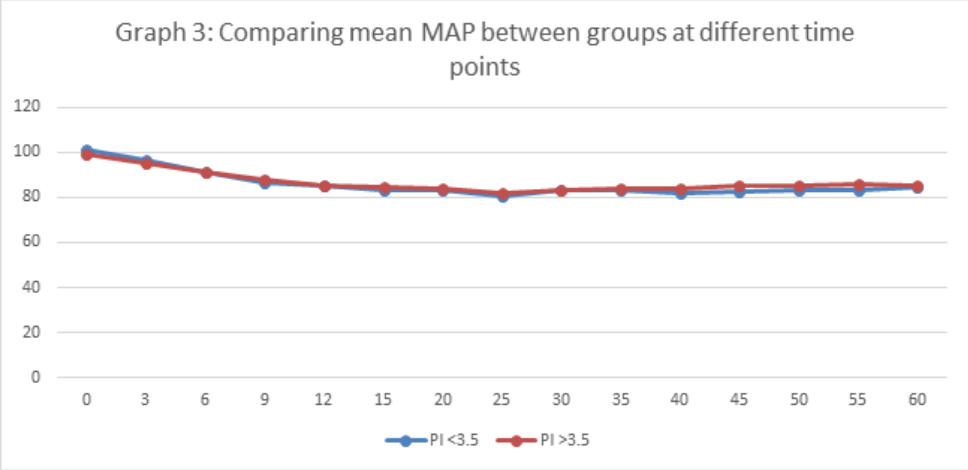
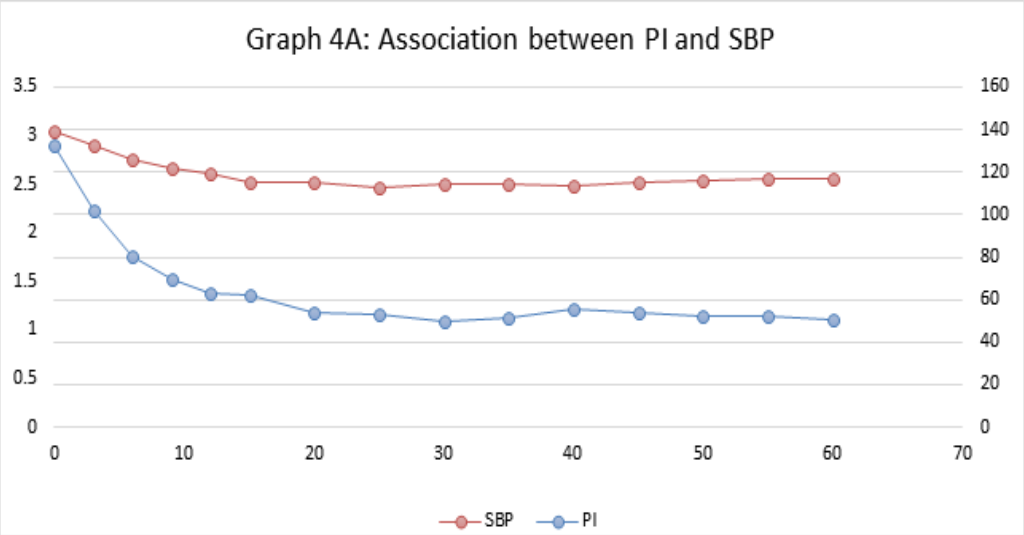


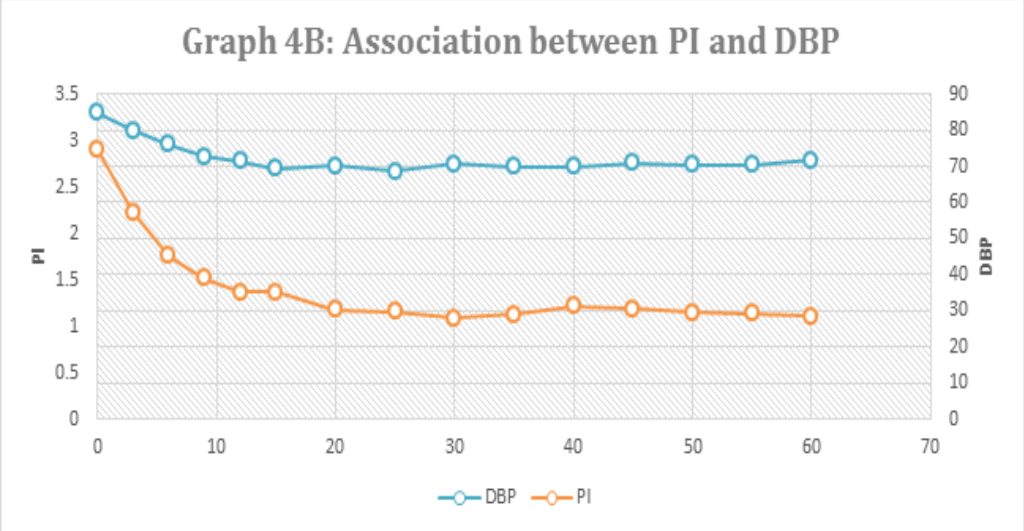
Table 4: Comparing mean HR between groups at different time points

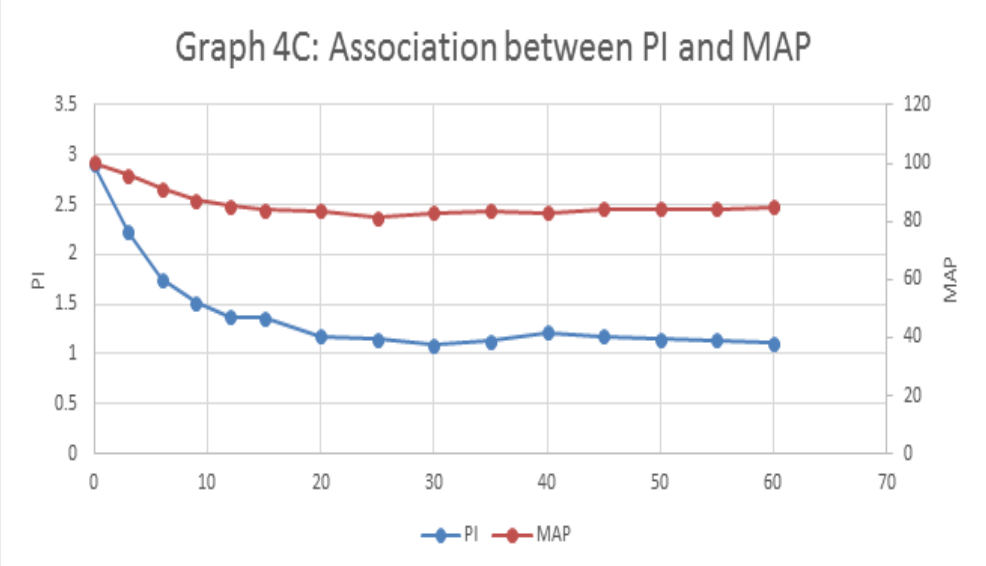
Time points (min)	Groups						P value
	Group A PI <3.5		Group B PI >=3.5		Total		
	Mean	SD	Mean	SD	Mean	SD	
0	86.68	16.400	87.62	15.014	87.15	15.706	0.585
3	82.87	13.690	83.40	13.310	83.13	13.483	0.720
6	78.04	12.870	78.28	11.686	78.16	12.274	0.861
9	78.32	13.773	77.63	11.237	77.97	13.870	0.033
12	72.61	11.521	72.69	11.085	72.65	11.288	0.950
15	70.32	10.158	71.59	11.221	70.96	10.705	0.281
20	69.75	9.826	71.87	10.590	70.81	10.255	0.059
25	69.24	9.225	71.07	10.038	70.16	9.669	0.086
30	68.55	9.868	71.03	10.527	69.79	10.262	0.028
35	68.05	8.479	70.63	9.832	69.34	9.257	0.011
40	68.00	8.744	70.97	9.734	69.48	9.357	0.004
45	68.51	8.767	71.50	10.009	70.00	9.513	0.004
50	69.23	9.626	71.58	10.044	70.40	9.892	0.031
55	69.50	10.011	71.72	9.992	70.61	10.048	0.045

Table 5: Association between SBP, DBP and MAP with PI

Time line	PI_{mean}	SBP_{mean}	DBP_{mean}	MAP_{mean}
0	2.903	139.42	84.93	100.19
3	2.2288	132.91	80.02	95.98
6	1.753	126.30	76.00	91.16
9	1.515	122.14	72.69	87.12
12	1.370	119.50	71.50	85.25
15	1.3658	115.62	69.33	83.88
20	1.1768	114.85	70.12	83.52
25	1.1539	112.37	68.60	81.36
30	1.0895	114.80	70.55	83.10
35	1.1260	114.36	69.99	83.48
40	1.2128	113.28	69.93	82.83
45	1.1829	115.41	70.87	84.14
50	1.1461	116.00	70.39	84.28
55	1.1354	116.72	70.40	84.34
60	1.1073	116.58	71.61	84.90
P value	0.023	0.001	0.011	0.032


Graph 4A: Association between PI and SBP
3.5
3
2.5
2
1.5
1
0.5
0
160
140
120
100
80
60
40
20
0
0
10
20
30
40
50
60
70
SBP
PI


Graph 4B: Association between PI and DBP
PI
DBP
3.5
3
2.5
2
1.5
1
0.5
0
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
DBP
PI


Graph 4C: Association between PI and MAP
PI
MAP
3.5
3
2.5
2
1.5
1
0.5
0
120
100
80
60
40
20
0
0
10
20
30
40
50
60
70
PI
MAP

Result

Age distribution between groups. Majority of the patients with group A had age between 41-50 years (30.3%) followed by 31-40 years (27.3%), similarly majority of the patients with group B had age between 41-50 years (30.9%) followed by 31-40 years (24.8%). However, no significant difference was found in terms of age distribution between both the groups as revealed by the insignificant p value of 0.234.Sex distribution between groups. Majority of the patients in present study were males (64%) compared to females (36%). However, no significant difference was found in terms of sex distribution between the two groups. The p value of this comparison was 0.482 which is insignificant.

Table 3 shows the comparison of mean PI between groups at different time points. Mean PI was significantly higher in patients with group B compared to those group A at all the time points except at 15 min (p=0.109) and at 40 min (p=0.093). Comparison of mean SBP between groups at different time points. No significant difference was obtained in SBP from baseline till 25 min (p>0.05), however, from 30 min onwards, SBP was found to be significantly higher in patients with PI >3.5 compared to those with PI <3.5 till 55 min. At 60 min SBP was found to be similar in both the groups as revealed by the insignificant p value of 0.126.

Graph shows the comparison of mean DBP between groups at different time points. No Significant difference was recorded in DBP from baseline till 35 min. From 40 min onwards a significant difference was reported in DBP till 60 min between both the groups. DBP was significantly higher in those with PI>=3.5 from 40 min onwards till 60 min compared to those with PI <3.5 min as revealed by the significant p value of <0.05.Graph shows the comparison of mean MAP between groups at different time points. No significant difference in mean MAP was reported in those with PI more than 3.5 compared to those with PI <3.5 at all the time points except at 40 min (p=0.009), 45 min (p=0.008) and at 55 min (p=0.002).

Table 4 shows the comparison of mean HR between groups at different time points. No significant difference was reported in heart rates of patients in both the groups from baseline till 25 min. From 30 min onwards heart rate was significantly high in PI >3.5 group till 55 min compared to patients with PI <3.5. At 60 min no significant difference was noted in heart rate between both the groups (p=0.182).Table 5 shows the association between SBP_{mean}, DBP_{mean} and MAP_{mean} with PI. A decreasing trend was observed in SBP (p=0.001), DBP (p=0.011) and MAP (p=0.032) with decreasing PI from baseline to 60 min.

Statistical Analysis: All the data analyses were performed using IBM SPSS ver. 25. Frequency distribution and cross tabulation was performed to prepare the tables. Quantitative data is expressed as mean and standard deviation whereas categorical data is expressed as number and percentages. Chi Square test was used to find out the association between proportions whereas mean was compared using one way ANOVA. Microsoft office and PRISM software was used to prepare the graphs. Scattered plot was prepared for representing multiple parameters for generating secondary axis. P value of <0.05 is considered as significant.

Discussion

We considered perfusion index to be a useful tool for assessment of hypotension following spinal anaesthesia in advance of blood pressure measurement by conventional non-invasive methods. [10] We conducted this prospective observational study with the aim to observe if the baseline perfusion index value could predict the incidence of hypotension (MAP<65 mm Hg).

We followed perfusion index, systolic blood pressure, diastolic blood pressure and mean arterial pressuretill 60 minutes after subarachnoid block to establish a

relationship between the trend of these parameters. [11] Change in mean perfusion index, PI_{mean} from baseline till 60 min was significant with p value=0.023, change in mean systolic blood pressure ($SBP_{mean)}$ was significant with p value=0.001, change in diastolic blood pressure (DBP_{mean}) was significant with a p value=0.011, change in mean arterial pressure (MAP_{mean}) was significant with a p value=0.032

S Toyama, M. Kakumoto and others conducted a study (2013) to predict whether baseline perfusion index could predict the incidence of hypotension after spinal anaesthesia in parturients. They found that higher baseline perfusion index (PI>=3.5) was associated with a marked decrease in blood pressure after spinal anaesthesia. [12,13] 21 parturients(60%) out of 35 under study developed hypotension following spinal anaesthesia. 19 parturients (54%) had a higher baseline PI (>=3.5). No significant difference was noted between the two groups with respect to number of hypotensive episodes (MAP<65mm Hg) with a p value of 0.628

Duggappa DR et al conducted a study in 2014 in 126 parturients. They were divided amongst two groups of perfusion index cut-off value of PI 3.5 as elicited by S. Toyama et al. Incidence of hypotension in group with PI<3.5 was 10.5% compared to 71.42% in in group with PI>=3.5 (p value<0.001) [7]. Like this study, we took a reference cut-off range for perfusion index as 3.5 but, our study group included general population from 21 to 60 years of age. We found no significant difference between the two groups with respect to number of episodes of profound hypotension (MAP<65 mm Hg) [14]

Yokose et al performed a study (2015) to find predictors of spinal hypotension. They found that non-invasive hemodynamic parameters derived from peripheral plethysmograph like perfusion index and pleth-variability index may not be a reliable parameter to predict incidence of hypotension following spinal anaesthesia [31].They concluded that only pre-operative heart rate derived from pulse oximeter before giving anesthesia may be used for predicting hypotension. Our study also concluded that baseline perfusion index is unable to predict incidence of profound hypotension (MAP<65 mm Hg) following spinal anaesthesia but our methods were different. We did not administer intravenous colloids after subarachnoid block. We defined hypotension as mean arterial pressure less than 65 mm Hg. [15-18]

Dr. Joseph George et al conducted a study in 2019 to find out the correlation between baseline perfusion index and incidence of hypotension following sub arachnoid block in Lower segment caesarean section . It was concluded that Baseline perfusion index >3.6 is associated with higher incidence of hypotension following SAB in elective caesarean delivery. Our study population was different from this study. Also the definition of hypotension was different in our study. [19]

Changes in vascular tone of peripheral vessels in pregnancy may affect the degree of hypotension after spinal anaesthesia. Decrease in peripheral vascular tone will lead to pooling of intravascular volume towards the extremities even before spinal anaesthesia among parturients at term. So, above discussed studies demonstrated that a higher baseline perfusion index was associated with a greater decrease in blood pressure during lower segment caesarean section under spinal anaesthesia and larger doses of vasopressors or inotropes were used to maintain normal blood pressure. We conducted our study in patients of age group 20 years to 60 years who underwent abdominal and lower extremity surgeries under spinal anaesthesia. So our population group under study was different from the previous studies discussed above which were done on parturients undergoing lower segment caesarean section. [20]

Sripada G. Mehandale and PreethiRajasekhar in 2016 studied the relation of baseline perfusion index (an indicator of systemic vascular resistance) to predict hypotension following induction of

general anaesthesia using propofol and determine a cut-off value of perfusion index to predict hypotension following induction. They concluded that baseline perfusion index less than 1.05 could predict incidence of hypotension at 5minutes with a sensitivity of 93%, specificity of 71%. Positive predictive value of 68% and a negative predictive value of 98% (p value<0.001). [21]

Mowafi et al conducted a study in 2009 to evaluate if Perfusion index could detect intravascular injection of an epidural test dose containing 15 mcg of epinephrine during total intravenous anaesthesia with propofol and comparing its reliability with the conventional heart rate changes (>=10 beats per minute) and systolic blood pressure change (>=15 mm Hg) criteria. Using the new criterion i.e. changes in perfusion index for intravascular injection (more than 10% decrease in PI from the pre-injection value) the sensitivity, specificity, positive predictive, and negative predictive values (NPV)were 100% (95% confidence interval [CI]; CI = 83%-100%). On the contrary, sensitivity of 95% (CI = 76%-99%) and 90% (CI = 70%-97%) were obtained based on the basis of heart rate and SBP respectively. [22] This study suggests that we may check response of vasoactive agents administered intra-operatively by monitoring perfusion index.

In a similar study, Mallawaarachchi et al conducted a study to determine whether the trend of the perfusion index changes could find possibility of hypotension before changes in blood pressure values measured by conventional methods and to find the effect of the oxytocin and IV ephedrine bolus on perfusion index. They studied changes in PI to check response for intravenous ephedrine. They concluded that Perfusion index appeared to increase significantly and more quickly in parturients with significant hypotension. Response to intravenous ephedrine bolus can be assessed by the change in the PI. Effect to the vascular tone by oxytocin is significant with 5IU bolus, though it does not cause a significant blood pressure drop. Non-invasive blood pressure (NIBP) monitoring is done intra-operatively to ensure adequate blood supply to all the organs during surgery. Perfusion index is continuously displayed on the multipara monitors. We studied the trends of change in perfusion index with blood pressure changes and compared them to establish relationship between perfusion index and NIBP.

Sympathectomy in lower trunk and lower limbs after spinal anaesthesia leads to peripheral vasculature dilatation indicated by an increase in perfusion index when measured at toes . Peripheral vasoconstriction occurs in rest of the upper body which is spared of sympathetic blockade and is reflected by a trend of fall in peripheral perfusion index measured in upper limbs after spinal anesthesia.

PI is determined by a number of factors. Some authors have described perfusion index to be mainly dependent on vascular tone. Alternating component (AC) is an impression of variations of absorbance of the incident light beams due to pulsatile vessels under arterial pressure and volume variations. Recent studies suggest that perfusion index is strongly influenced by stroke volume . Van Genderen et al exposed healthy volunteers to a lower body negative pressure where they observed a rapid fall in perfusion index from 2.2% to 1.3% which suggested that PI was influenced by stroke volume. Body position has an influence on the values of PI. Highest values of PI were observed in trendelenberg position and lowest in sitting position, suggesting a positive relationship between PI and stroke volume .

Systemic factors affecting values of perfusion index include intravascular volume status, venous return, stroke volume, vascular tone, arterial stiffness, vasoactive or cardiac medications & vasodilator effects of anaesthetic drugs. Local factors affecting PI values are position of the limb in relation to heart, vascular compression, local temperature

exposure, local arterial compliance, body position and soft tissue compression.

So, we cannot predict incidence of profound hypotension (MAP<65 mm Hg)on the basis of baseline PI value in patients aged 21 to 60 years as it is dependent on multiple factors. Also the changes in perfusion index are seen with changes in blood pressure measurement but these values are not consistent and reliable.

Conclusion

We concluded that baseline perfusion index cannot predict the incidence of profound hypotension following spinal anaesthesia in general population. Trends of fall in perfusion index after spinal anaesthesia was observed with decreasing, systolic, diastolic and mean blood pressures but, perfusion index is not a reliable parameter to indicate changes in blood pressure.

Declarations:

Funding: None

Availability of data and material: Department of Anaethesiology L.N. Medical College and J K Hospital

Code availability: Not applicable

Consent to participate: Consent taken

Ethical Consideration: There are no ethical conflicts related to this study.

Consent for publication: Consent taken

Limitations Of Our Study:

1. Values of Perfusion index is dependent on multiple factors like intravascular volume status, venous return, stroke volume, vascular tone, arterial stiffness, vasoactive or cardiac medications, position of the limb in relation to heart, vascular compression, local temperature exposure, local arterial compliance, body position and operation theatre lights.
2. Amount of intravenous fluid given was not recorded and compared.
3. Momentary changes in perfusion index (after administration of vasoactive drugs) were not taken into account.
4. Blood loss and third space fluid loss were not studied.

Contribution by Different Authors

First author Dr. Mayank Karode Senior Resident Department Of Anaesthesiology, LNMC Bhopal Data collection and statistical analysis

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Third author Dr. Sunil Kumar Rajpoot Assistant Professor Department of Anaesthesiology, LNMC Bhopal Data collection and statistical analysis

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Fifth author Dr. Anil Bhati, Professor Department of Anaesthesiology, LNMC Bhopal**.** Concept and Guidance

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