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Perfusion index as a predictor of hypotension following propofol induction- A prospective observational study:

Asif Hussain[1], *Humera Manzoor [2], Syed Mohsin Manzoor [3], Arshi Taj[4], Mohammad Ommid[5].

1. Registrar, Department of Anaesthesiology, Govt. Medical College, Baramullaha, India.
2. Assistant Professor, Department of Anesthesiology & Critical Care, Govt. Medical College, Srinagar, India.
3. Mch, CVTS SKIMS Soura Srinagar India.
4. Associate Professor, Department of Anesthesiology & Critical Care, Govt. Medical College, Srinagar, India.
5. Professor, Department of Anesthesiology & Critical Care, Govt. Medical College, Srinagar, India.

ABSTRACT

Background and Aim: Perfusion index (PI) is a relatively new parameter estimating the pulsatility of blood in the extremities, calculated using infrared spectrum as part of plethysmography waveform processing. Hypotension during propofol induction is a common problem. The aim of this study was to detect whether a baseline PI >3.5 predicts the development of hypotension after propofol induction. **Methods:** sixty patients of (ASA) physical status I-II of both sexes, aged between 18 to 60 years, equally divided in to two groups, Group A (PI<3.5,n=30) and Group B (PI>3.5, n=30), undergoing elective surgical procedures were enrolled in this observational study. PI, heart rate, blood pressure (BP) and oxygen saturation were recorded every minute from baseline to 10 min following induction of anaesthesia with propofol, and after endotracheal intubation. Hypotension was defined as fall in systolic BP (SBP) by >30% of baseline or mean arterial pressure (MAP) to <60 mm Hg. **Results:** Within first 10-min after induction, the incidence and severity of hypotension was higher in patients in group B whose baseline PI values were greater than 3.5. The mean heart rate, mean systolic blood pressure and mean diastolic blood pressure was found to be lower in patients of Group B after the intubation while patients of Group A did not show much variation with p value of < 0.05. **Conclusion:** Perfusion Index (PI) can be used as a tool for predicting hypotension in healthy patients undergoing elective surgeries under general anaesthesia. Patients with baseline PI >3.5 (Group II) are at higher risk of developing hypotension compared to those with baseline PI ≤3.5 (Group I).

Key words: Perfusion index, Blood pressure, general anaesthesia, propofol.

Introduction:

Propofol is the drug of choice for induction of anaesthesia in millions of patients every year because of its rapid onset and short duration of action, easy titration, and favorable profile for side effects .1 Despite these positive attributes , it is associated with hypotension on induction of anaesthesia.2,3 At cellular level, propofol induces the release of nitric oxide, acts as a calcium-channel blocker and activates protein kinase C.4,5 Hence, clinically, the administration of propofol leads to a decrease in cardiac output and arterial pressure.6,7 Non-invasive blood pressure (NIBP) measurement is the standard method of monitoring intraoperative haemodynamics. However, beat to beat variation in perfusion dynamics cannot be measured by this method and limits its efficacy.

Perfusion index (PI) is a relatively new parameter estimating the pulsatility of blood in the extremities, calculated using infrared spectrum as part of plethysmography waveform processing. It is a simple, cost-effective and non-invasive method of assessing peripheral perfusion determined by the percentage of pulsatile to non-pulsatile blood flow in the extremities. PI indicates the status of the microcirculation which is densely innervated by sympathetic nerves, and therefore, is affected by multiple factors responsible for vasoconstriction or vasodilatation of the microvasculature. It is also purported to be an indicator of systemic vascular resistance (SVR)8 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.9 It has been established that a positive correlation between pre-anaesthetic plethysmographic variability index (PVI) and reduction in BP following induction of anaesthesia using propofol in healthy adults, that is, higher PVI was associated with more mean arterial pressure (MAP) reductions.10

Methods:

The present study was conducted in the department of Anaesthesiology and Critical Care in Government Medical College Srinagar from April 2018 to April 2020. Sixty patients of (ASA) physical status I-II of both sexes, aged between 18 to 60 years, equally divided in to two groups, Group A (n=30) and Group B (n=30), undergoing elective surgical procedures were included in this observational study. After getting approval from Institutional Ethical Committee, written informed consent was obtained from all the patients before surgery.

All patients were transported to the operating room without premedication. On arrival to operating room, an 18-gauge intravenous (IV) catheter was inserted and 6ml/kg/h crystalloid was infused intraoperatively, monitoring of electrocardiography, non-invasive blood pressure, oxygen saturation (SpO2) was started and baseline values were recorded. The perfusion index was measured using specific pulse oximeter probe attached to the left index finger of all patients to ensure uniformity in measured PI values. Pre-oxygenation with 100% oxygen (O2) was done for 3 min. General anaesthesia was induced with IV propofol 2.0–2.5 mg/kg followed by injection Atracurium 2 mg/kg to facilitate orotracheal intubation. The trachea was intubated with a cuffed orotracheal tube of appropriate size. Anesthesia was maintained with

60% N2O in oxygen with 0.5–1% isoflurane. Intermittent boluses of atracurium bromide were used to achieve muscle relaxation. Minute ventilation was adjusted to maintain normocapnia (end tidal carbon-dioxide [EtCO2] between 34 and 38 mm Hg) and EtCO2 was monitored. Hypotension/hypertension was defined as fall/rise in systolic blood pressure of >20% from the baseline values and bradycardia/tachycardia was defined as fall/rise in pulse rate of >20% from the baseline values. Haemodynamic fluctuations were to be managed accordingly.

The neuro-muscular blockade was antagonized with neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg and trachea was extubated, and the patient was shifted to post-anaesthesia care unit (PACU).

Patients and groups:

Patients were allocated to one of the groups based on the perfusion index. Each group consists of 30 patients. Groups were as follows:

Group A: with PI < 3.5

Group B: with II PI > 3.5.

Haemodynamic parameters were recorded at 1-min intervals till 10 min after intubation. Hypotension was defined as a drop in SBP to <30% of baseline or absolute MAP <60 mmHg. MAP <55 mmHg (severe hypotension) was treated immediately by rapid intravenous fluid administration (10 ml/kg) and mephentermine 6 mg IV boluses. Bradycardia was defined as HR <50 bpm or decrease by more than 30% below baseline value, whichever was lower and was treated with atropine 0.6 mg IV boluses. The incidence of hypotension was calculated in 2 sets – 5 min after induction of anaesthesia (effect of induction agent) and first 15 min after induction (effect of induction process and endotracheal intubation). A cut-off value of baseline PI below which hypotension at 5 min post induction could be predicted was the primary outcome, while positive and negative predictive values at 15 minutes were secondary outcomes. The sample size was calculated to observe effect size of at least 0.45 based on a study for correlation of PI and change in the MAP after propofol induction. Data were collected and computed using Microsoft Excel 2007 (Microsoft Corporation, Redmond, Washington, 2007) and analysed using SPSS version 20 (IBM Corporation, New York, 2014). Data were represented as mean (±standard deviation) for quantitative variables and percentages for qualitative variables. Distribution of PI was subjected to normality test ($P < 0.001$). The point-biserial correlation was used for examining the association between baseline PI and hypotension incidence. Spearman's ρ was used for testing correlation between PI and all haemodynamic variables, and linear regression was applied to identify independent predictability if univariate correlation was found. Receiver operating characteristic (ROC) curves were constructed for values of baseline PI for predicting hypotension (SBP <30% below baseline). $P < 0.05$ was considered statistically significant.

Results:

Both the study groups were comparable with respect to age, sex, weight, height, ASA class and duration of surgery, as p-value was >0.05. No statistical difference (p-value > 0.05) existed among the two groups as regards to demographic profile (Table1).

Table1: Comparison of demographic profiles between the study groups:

Parameters	Group A	Group B	P value
Age (yrs)	42.5±16.25	38.4±11.31	0.649*
Sex Male/female	17/13	19/11	0.73*
Weight (kg)	61.50±8.87	62.51±10.99	0.82*
Height (cms)	166.3±4.61	168.4±5.54	0.264*
ASAI/II	23/7	21/9	0.431*
Duration of surgery	57.50±11.92	55.80±10.93	0.881*

(* = Level of significance, Mean±SD standard deviation)

The mean values of preoperative heart rate, systolic blood pressure, diastolic blood pressure, oxygen saturation and respiratory rate among the two study groups was statistical not significant with p value (p-value<0.001) Fig 1.

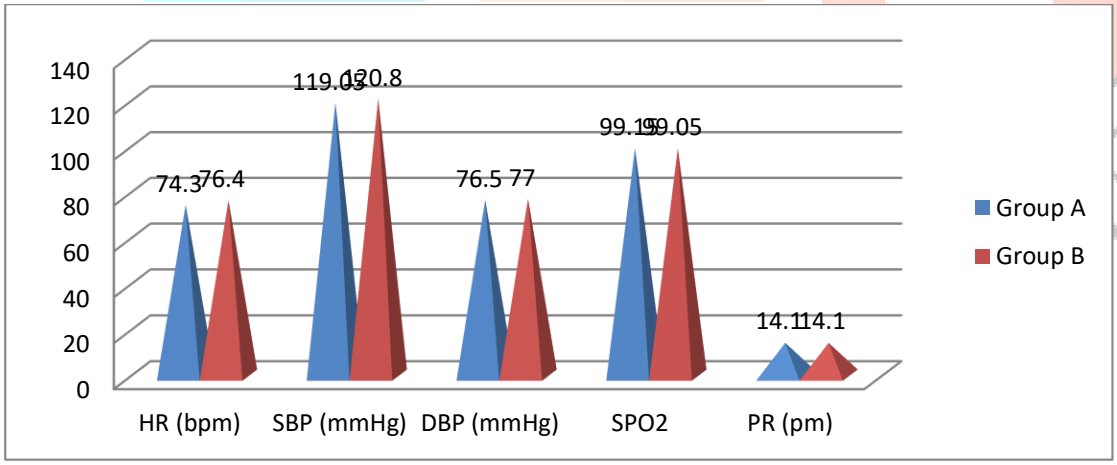
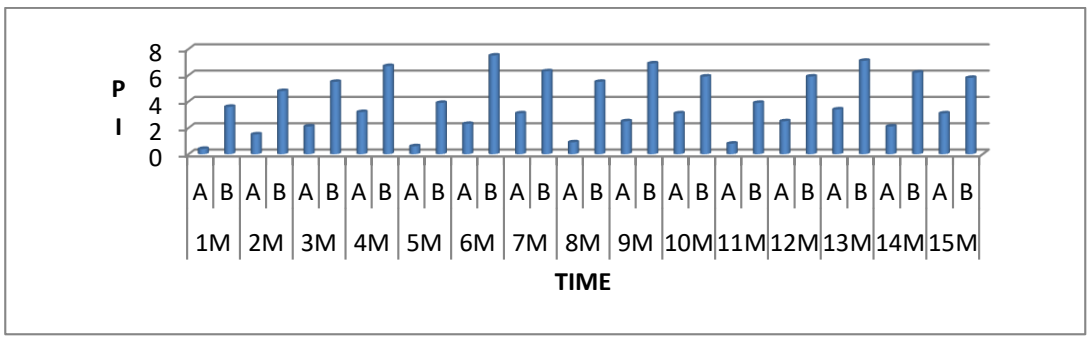


Fig.1

The incidence and severity of hypotension was higher in patients in group II whose baseline PI values were greater than 3.5 (Fig 2).



The baseline values of mean heart rate and systolic blood pressure were comparable between the groups with no statistical significance. Though mean heart rate values were comparable during intra operative period between the groups but bradycardia (heart rate < 54 beats/min) was observed in two patients of Group A which promptly responded to intravenous atropine. The mean heart rate was found to be lower in patients of Group B after the intubation while patients of Group A did not show much variation in their mean heart rate values (Table2).

Table-2: Intra operative Heart Rate.

Time	Group	Mean	P-value
Baseline	A	76.10±10.66	
	B	71.10±13.16	0.19
After Intubation	A	92.80± 9.56	
	B	76.20± 10.59	0.29
2 min after intubation	A	87.15±8.61	
	B	78.60±11.70	0.012
5 min after intubation	A	79.15±6.39	
	B	69.50±8.14	0.0002
10 min after intubation	A	72.50±7.28	
	B	63.30±7.11	0.0002
15 min After intubation	A	90.55±9.34	
	B	64.55±5.70	0.003

The baseline values of mean systolic blood pressure were comparable between the groups with no statistical significance. But mean systolic blood pressure values shows statically significant difference during intra operative period between the groups The mean systolic blood pressure was found to be lower in patients of Group B as compared to Group A with p value of < 0.05 (Table3).

Table-3: Intra Operative Systolic blood pressure.

Time	Group	Mean	P-value
Baseline	A	119.55	
	B	120.75	0.38
After Intubation	A	119.05	
	B	119.65	0.225
2 min after intubation	A	119.75	
	B	105.25	0.016
5 min after intubation	A	119.15	
	B	90.02	0.004
10 min after intubation	A	120.67	
	B	85.60	0.012
15 min After intubation	A	115.35	
	B	87.45	0.002

The baseline values of mean diastolic blood pressure were comparable between the groups with no statistical significance. But mean diastolic blood pressure values shows statically significant difference during intra operative period between the groups The mean diastolic blood pressure was found to be lower in patients of Group B as compared to Group A with p value of < 0.05 (Tble4).

Table-4: Intra Operative Diastolic blood pressure.

Time	Group	Mean	P-value
Baseline	A	78.25	0.336
	B	77.85	
After Intubation	A	79.70	0.335
	B	78.30	
2 min after intubation	A	77.10	0.059
	B	62.65	
5 min after intubation	A	78.30	0.01
	B	58.25	
10 min after intubation	A	77.35	0.015
	B	50.20	
15 min After intubation	A	80.40	0.005
	B	48.70	

Discussion:

Perfusion index is an indirect, non invasive, numerical, dynamic and continuous measure of peripheral perfusion obtained from pulse oximeter that provides useful information to the physician in several clinical settings. Perfusion index is reliable and easier alternative for detection of stress response during induction11 and peri-operative period of operation and has a prognostic value in predicting peri-operative outcome.12 Trends in change of perfusion index reveals even the subtle changes in peripheral circulation that is otherwise missed in static display. In anaesthetic settings spike in perfusion index indicates onset of anaesthesia at the physiological level and gives physicians one more tool to further consolidate onset of anaesthesia13-17.Peripheral Perfusion index alterations are more marked in patients who are likely to develops severe complications. Studies are also showing that treatment based on perfusion index can lead to improved patient outcome.

In the present study, we hypothesized that baseline PI will be useful in predicting hypotension following propofol and looked for a cutoff value that predicted hypotension. Our observations support this notion as there was a correlation between PI and incidence of hypotension. PI >3.5 was associated with a higher incidence of hypotension.

A multicentre study on haemodynamic effects of propofol in 25000 patients reported the occurrence of hypotension well beyond 10-min post-induction.18 More than 20% of hypotensive episodes occurred beyond 10-min post-induction. Our findings are also in agreement with this, as the observation period was 15-min post-induction, emphasising the need for continued vigilance well into maintenance period. Nevertheless, evidence supports association between post-induction hypotension and higher incidence of post-operative mortality and morbidity.19 Further, occurrence of post-operative acute kidney injury following transient intraoperative hypotension with MAP <55 mmHg has been confirmed.20 Hence, predicting, preventing and effectively treating any haemodynamic instability especially hypotension is very vital in ensuring best patient outcome after surgery. PI greater than 3.5 suggests that propofol induction is unlikely to result in hypotension.

In our study, the incidence and severity of hypotension was higher in patients in group II whose baseline PI values were greater than 3.5. 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 3.5 as the cut-off point for predicting hypotension in patients undergoing general surgical procedure under general anaesthesia.

In our study we found that higher the PI higher will be the chances of hypotension with new cut-off point of 3.5 whereas study conducted by Duggapa ,21 Toyama , Kuwata and Yokose was done in caesarean sections and in study of Lima , it stated that perfusion index can be used as noninvasive indicator for peripheral perfusion. The cut-off value of baseline perfusion index for prediction of hypotension following spinal anaesthesia was chosen as 3.5 based on a study conducted by Toyama *et al* .22 who did regression analysis and ROC curve analysis and concluded that a baseline perfusion index cutoff point of 3.5 could be used to identify patients at risk for such hypotension. An attempt was made to explore the predictive ability of this value in the Indian population, in this study. Further, only the baseline value was considered for analysis, since we did not try to explore the correlation between changes in serial PI values with the incidence of hypotension. In this study, the baseline PI >3.5 and probability of hypotension were significantly correlating, a finding similar to study by Toyama *et al*.22

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 noninvasive tool to predict hypotension following spinal anaesthesia. In addition, further studies comparing PI with invasive and accepted tools of haemo-dynamic monitoring may throw more light regarding its utility. There is a need to verify the cut-off value of PI for predictability by studying adequate number of patients in general as well as subcategory of patients such as specific age group, obese, hypertensive patients, etc.

Further, comparison between PI and PVI could have indicated superiority of one index over the other. Available literature does not mention effect of age on PI. Hence, cut-off value inferred in the current work may not be universally applicable, considering the possibility of increasing vascular tone with advancing

age, which may be one of the risk factors for propofol-induced hypotension in the elderly. Future research may also focus on incorporating advanced warning systems among clinical monitors in preventing hypotension at the time of anaesthesia.

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