Effectiveness of plethysmographic variability index for prediction of subarachnoid block induced hypotension in caesarean section

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Abstract

Background: *Hypotension is frequently observed after spinal anaesthesia for cesarean section and can be detrimental to both mother and baby. The pleth variability index (PVI) is a new algorithm used for automatic estimation of respiratory variations in pulse oximeter waveform amplitude, which might predict fluid responsiveness. Because anaesthesia-induced hypotension may be partly related to patient volume status. The pleth variability index (PVI) was developed as a noninvasive bedside measurement of this variation in the pulse oximetry waveform.*

Objective: *To observe the hypotension predictive capacity of PVI and to find out association & correlation of PVI with sphygmomanometeric blood pressure measurement.*

Methods: *This observational study was carried out in the department of anaesthesia, Analgesia and Intensive Care Medicine Bangabandu Sheikh Mujib Medical University, Dhaka between July 2015 to Dec 2015. A total 100 elective caesarean section patients under subarachnoid block were selected by the inclusion and exclusion criteria. Patients who fulfill the ASA physical status i, ii. and full term singleton pregnancy height from 152cm to160cm. were included and patients suffering from obesity (body weight>115 kg), hypertension, COPD, bronchial asthma, haemoglobinopathies, severe anaemia, arrythmia, heart failure, any congenital heart disease, pre-eclampsia, total placenta praevia or patient who took anti hypertensive medications were excluded from the study. Patients were divided in two groups, PVI ≥22.0 in group-A and PVI <22.0 in group-B.*

Dehydration was corrected 10 min before sub arachnoid block (sab). Pre–anesthetic Himoglobin% SPO2, Heart rate, PVI & blood pressure was recorded at baseline after 5 minutes of rest by one anesthesiologist. Subarachnoid block performed with 0.5% hyperbaric bupivacaine (12.5 mg) at the L_3-L_4 intervertebral space on sitting position. After spinal block patient was returned to supine position with a wedge under buttock to facilitate left uterine displacement. Oxygen 4 lit/min was administered via face mask. Immediately after sub arachnoid block Spo_2, heart rate, SBP and DBP was recorded by another anesthesiologist at 2 minutes interval in first 10 minute. Surgical incision was allowed when a block level at least T_6 dermatome was obtained with cold & pin prick.

All data was recorded by two anesthesiologist who were not involved in the study. The study ended with delivery of the baby. Chi-Square test was used to analyze the categorical variables, shown with cross tabulation. Student t-test was used for continuous variables. p value <0.05 was considered as statistically significantly.

Result: *In baseline, majority (58.0%) patients was found PVI e"22 (group A) and 42(42.0%) was PVI <22 (group B). Mean age of the patients was 27.5±4.5 years, Mean heart rate was found 93.2±5.8 beats/min in group A and 89.7±12.7 beats/min in group B. The mean systolic BP was found 132.1±7.7 mmHg in group A and 128.7±8.5 mmHg in group B. The mean diastolic BP was found 80.9±3.8 mmHg in group A and 79.1±5.1 mmHg in group B. The mean MAP was found 98.0±5.6 mmHg in group A and 95.6±6.8 mmHg in group B. The mean SPO_2 was found 97.8±1.4 in group A and 97.4±1.5 in group B. The mean perfusion index was found 5.0±2.6 in group A and 5.4±3.5 in group B. The mean pleth variability index*

was found 22.5±2.3 in group A and 15.1±3.1 in group B. The mean pleth variability index was statistically significant (p<0.05) between two groups.

***Conclusion:** Higher baseline pleth variability index can associated with hypotension after spinal anaesthesia for cesarean section may be a clinically useful predictor.*

***Key words:** Plethysmographic variability index(PVI), subarachnoid block, hypotension*

Introduction:

Sub arachnoid block is one of the central neuroaxial blocking technique of involving injection of a local anaesthetic within the subarachnoid space at the level of lower lumber vertebrae. The sympathectomy produced by subarachnoid block induces hemodynamic changes. Arterial and venodilation both occur in SAB and combine to produce hypotension. Hypotension is frequently observed after sub arachnoid block(SAB) in caesarean section and can be detrimental to mother as well as fetus.Severe or sustained hypotension may lead to cardiac arrest & irreversible brain damage. However no easy and convenient indexes to predict hypotension before subarachnoid block have been reported. Masimo Pulse CO-Oximetry is a Motion and Low Perfusion pulse oximeter.pleth variability index (PVI)is non-invasive and convenient dynamic indicator of fluid responsiveness which can be used to detect risk for mean arterial pressure (MAP) decreases and consequently hypotension during sub arachnoid block(SAB).[1]

Plethysmograph variability index or PVI , is a new introducion of noninvasive measurement that quantifies changes in the plethysmosgraphic waveform. It is a graphical display of the changes in blood volume caused by arterial pulsation over the respiration cycle.So, PVI may be useful in monitoring surgical patients, both intraoperatively and postoperatively, for appropriate hydration states & blood pressure. For example, a rising PVI may indicate developing hypotension. PVI is appropriate to use to predict fluid responsiveness in most ICU and surgical patients. In general, PVI provides an accurate prediction of fluid responsiveness in mechanically ventilated adults under general anesthesia with a normal sinus rhythm. PVI is less accurate and therefore not recommended for patients with cardiac arrhythmia for the same reasons.

Methods: This observational study was carried out in the department of anaesthesia, Analgesia and Intensive Care Medicine Bangabandu Sheikh Mujib Medical University, Dhaka between July 2015 to Dec 2015 after the ethical clearance from institutional review board of BSMMU. Informed written consent was obtained from each patient before enrolling in this study. A total 100 elective caesarean section patients under subarachnoid block were selected by the inclusion and exclusion criteria. Patients who fulfill the ASA physical status *i, ii.* and full term singleton pregnancy height from 152cm to160cm. were included and patients suffering from obesity (body weight>115 kg), hypertension, COPD, bronchial asthma, haemoglobinopathies, severe anaemia, arrythmia, heart failure, any congenital heart disease, pre-eclampsia, total placenta praevia or patient who took anti hypertensive medications were excluded from the study. Patients were divided in two groups, PVI e"22.0 in group-A and PVI <22.0 in group-B.

Dehydration was corrected 10 min before sub arachnoid block (sab). Pre–anesthetic Himoglobin% SPO2, Heart rate, PVI & blood pressure was recorded at baseline after 5 minutes of rest by one anesthesiologist. Subarachnoid block performed with 0.5% hyperbaric bupivacaine (12.5 mg) at the L_3-L_4 intervertebral space on sitting position. After spinal block patient was returned to supine position with a wedge under buttock to facilitate left uterine displacement. Oxygen 4 lit/min was administered via face mask. Immediately after sub arachnoid block Spo_2, heart rate, SBP and DBP was recorded by another anesthesiologist at 2 minutes interval in first 10 minute. Surgical incision was allowed when a block level at least T_6 dermatome was obtained with cold & pin prick.

All data was recorded by two anesthesiologist who were not involved in the study. The study ended with delivery of the baby. Statistical analyses of the results were obtained by using window based

computer software devised with Statistical Packages for Social Sciences (SPSS-16). Chi-Square test was used to analyze the categorical variables, shown with cross tabulation. Student t-test was used for continuous variables. p value <0.05 was considered as statistically significantly.

Results:

Table I *Distribution of the study patients by baseline parameters (n=100)*

Baseline parameters	Mean±SD
Age (in years)	27.5±4.5
Heart rate (beats/min)	90.4±9.3
Spo_2	97.7±1.9
Hb%	11.7±0.9
BMI (kg/m^2)	24.5±6.5
Perfusion index	5.2±3.0
Pleth variability index	19.7±4.5
Systolic blood pressure (mmHg)	129.3±8.4
Diastolic blood pressure (mmHg)	80.2±3.7
Mean arterial pressure (mmHg)	96.6±4.6

Mean age was found 27.5±4.5 years, mean heart rate was found 90.4±9.3 beats/min, mean Spo_2 was found 97.7±1.9, mean Hb% was found 11.7±0.9 gm/dl, mean BMI was found 24.5±6.5 kg/m^2, mean perfusion index was found 5.2±3.0, mean pleth variability index was found 19.7±4.5, mean systolic blood pressure was found 129.3±8.4 mmHg, mean diastolic blood pressure was found 80.2±3.7 mmHg and mean MAP was found 96.6±4.6 mmHg.

Table II *Classification of patients according to PVI (n=100)*

Baseline PVI parameters of	No. of patients	Percentage
≥22 (group A)	58	58.0
<22 (group B)	42	42.0

In baseline, majority (58.0%) patients was found PVI ≥22 (group A) and 42(42.0%) was PVI <22 (group B).

Table III *Preoperative patients status (n=100)*

Baseline parameters	Group A (n=58) Mean±SD	Group B (n=42) Mean±SD	P value (n=58)
Heart rate (beats/min)	93.2±5.8	89.7±12.7	0.074[ns]
Systolic blood pressure (mmHg)	132.1±7.7	128.7±8.5	0.052[ns]
Diastolic blood (mmHg)	80.9±3.8	79.1±5.1	0.057[ns]
Mean arterial pressure (mmHg)	98.0±5.6	95.6±6.8	0.056[ns]
SPO_2	97.8±1.4	97.4±1.5	0.174[ns]
Perfusion index	5.0±2.6	5.4±3.5	0.533[ns]
Pleth variability index	22.5±2.3	15.1±3.1	0.001[s]

s= significant, ns= not significant
P value reached from unpaired t-test

Mean heart rate was found 93.2±5.8 beats/min in group A and 89.7±12.7 beats/min in group B. The mean systolic BP was found 132.1±7.7 mmHg in group A and 128.7±8.5 mmHg in group B. The mean diastolic BP was found 80.9±3.8 mmHg in group A and 79.1±5.1 mmHg in group B. The mean MAP was found 98.0±5.6 mmHg in group A and 95.6±6.8 mmHg in group B. The mean SPO_2 was found 97.8±1.4 in group A and 97.4±1.5 in group B. The mean perfusion index was found 5.0±2.6 in group A and 5.4±3.5 in group B. The mean pleth variability index was found 22.5±2.3 in group A and 15.1±3.1 in group B. The mean pleth variability index was statistically significant (p<0.05) between two groups.
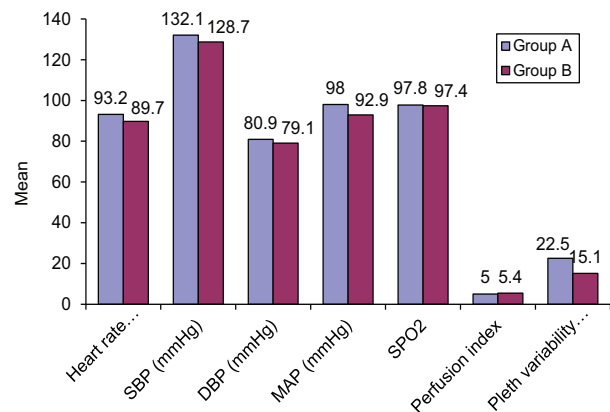

Fig 1 *Bar diagram showing comparison of baseline parameters between group A and group B.*

The mean pleth variability index was statistically significant (p<0.05) between two groups.

Table-4 *Systolic blood pressure dropped >20% and critical dropped >30% of baseline (n=100)*

	Group A(n=58)		Group B(n=42)		P value
	n	%	n	%	
Hypotension (SBP dropped >20% of baseline)	47	81.0	13	31.0	0.001[s]
Hypotension (SBP critically dropped >30% of baseline)	39	67.2	11	26.2	0.001[s]

s= significant
P value reached from chi square test

Table-5 *Positive and negative predictive value of baseline PVI for hypotension after spinal anesthesia*

Baseline PVI	Hypotension after induction	No hypotension after induction	Total
Positive (≥22.0)	47(True positive)	11(False positive)	58
Negative (<22.0)	13(False negative)	29(True negative)	42
Total	60	40	100

In baseline, majority (81.1%) patients was found systolic blood pressure dropped >20% mmHg in group A and 13(31.0%) in group B. More than two third (67.2%) patients was found systolic blood pressure critically dropped >30% in group A and 11(26.2%) in group B. The difference were statistically significant (p<0.05) between two groups.

Baseline PVI, true positive 47 cases, false positive 11 cases, false negative 13 cases and true negative 29 cases in identification by hypotension after spinal anesthesia.

Discussion:

In this present study it was observed that mean age was found 27.5±4.5 years, mean heart rate was found 90.4±9.3 beats/min, mean Spo_2 was found 97.7±1.9, mean Hb% was found 11.7±0.9 gm/dl, mean BMI was found 24.5±6.5 kg/m^2, mean perfusion index was found 5.2±3.0, mean pleth variability index was found 19.7±4.5, mean systolic blood pressure was found 129.3±8.4 mmHg, mean diastolic blood pressure was found 80.2±3.7 mmHg and mean MAP was found 96.6±4.6 mmHg. Similarly, Sun & Huang (2014) found mean age was 29.3±6.1 years, weight 74.3±9.3 kg, height 162±6.1 cm, BMI 29.2±7.6 kg/m^2, perfusion index 5.6±0.6 and pleth variability index was 20.6±5.9. In another study Tsuchiya et al. (2010) found Pre-anesthesia PVI varied from 7 to 28, with a mean value of 16±5.5.

In this current study it was observed that in baseline, majority (58.0%) patients was found PVI e"22 (group A) and 42(42.0%) was PVI <22 (group B). The mean hemoglobin was found 11.8±1.2 gm/dl in group A and 11.4±0.9 gm/dl in group B. The mean hemoglobin was almost alike between two groups.

In this study it was observed that mean heart rate was found 93.2±5.8 beats/min in group A and 89.7±12.7 beats/min in group B. The mean systolic BP was found 132.1±7.7 mmHg in group A and 128.7±8.5 mmHg in group B. The mean diastolic BP was found 80.9±3.8 mmHg in group A and 79.1±5.1 mmHg in group B. The mean MAP was found 98.0±5.6 mmHg in group A and 95.6±6.8 mmHg in group B. The mean SPO_2 was found 97.8±1.4 in group A and 97.4±1.5 in group B. The mean perfusion index was found 5.0±2.6 in group A and 5.4±3.5 in group B. The mean pleth variability index was found 22.5±2.3 in group A and 15.1±3.1 in group B. The mean pleth variability index was statistically significant (p<0.05) between two groups. Similarly, Wrench et al. (2015) found that the PI was higher during spinal anaesthesia in women who became hypotensive compared with those who did not (P<0.05). Sun & Huang (2014) observed that there was no significant difference in baseline hemodynamic parameters between patients who developed hypotension after spinal anesthesia compared with patients who did not. Baseline PVI in patients who developed hypotension was

significantly greater than PVI in patients who did not develop hypotension (P = 0.017) but there was no difference in the baseline PI. In another study Toyama et al. (2013) found that baseline PI ranged from 0.7 to 8.6, with a mean value of 4.0 (2.3). Twenty-one parturients (60%) developed hypotension; the maximum decrease in SAP from baseline ranged from 9.1–55.1%, with a mean value of 28.7%. Yokose et al. (2013) observed that pre-anesthetic PVI of patients who developed hypotension and who did not were 20.3±6.3%, and 16.8±5.3%, respectively (P <0.05), which are comparable with the current study.

Yokose et al. (2015) found the mean perfusion index was found 6.1±3.3 in group A and 5.9±2.2 in group B. The mean pleth variability index was found 18.4±6.6 in group A and 17.8±4.9 in group B. The mean heart rate was found 84.0±10 bpm in group A and 77±13 bpm in group B. The difference were not statistically significant (p>0.05) between two groups, which is comparable with the current study.

Baseline PVI was significantly related to the incidence of hypotension, whether the covariates were adjusted or not. Neither baseline PVI nor baseline PI were significantly related to the magnitude of the decrease in SBP (Sun & Huang 2014). In this present study it was observed that in baseline, majority (81.1%) patients was found systolic blood pressure dropped >20% mmHg in group A and 13(31.0%) in group B. More than two third (67.2%) patients was found systolic blood pressure critically dropped >30% in group A and 11(26.2%) in group B. The difference were statistically significant (p<0.05) between two groups. Similarly, George et al. (2010), demonstrated that a 100 or 120 mcg bolus was usually successful in reversing a 20% drop in systolic blood pressure (SBP) or SBP < 90 mmHg within 1 minute. No hypertensive episodes were observed in their study population although bradycardia was noted at 140 mcg.

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