Effect of oxytocin and vasopressors on Perfusion Index in pregnant women undergoing spinal block anesthesia for cesarean section .

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Abstract

Objective; Perfusion index is being regarded as a noninvasive monitoring aid for timely detection of hypotension following subarachnoid block. primary aim was to establish whether trend in Perfusion index(P I) detects hypotension before the changes in noninvasive blood pressure values.

Material and method; 104 pregnant women posted for elective caesarian section under Sub arachnoid block were included under the study convenience non-probability sampling. Following co loading with balanced salt solution, all patients received same dose of spinal bupivacaine with monitoring of haemodynamics.

Results: Spearman's rank-order correlation was run to determine the relationship between 104 patients' perfusion index and arterial blood pressure. There was a negative correlation between perfusion index and systolic blood pressure, (r = -0.308, n = 104 “P-value” < 0.01) and mean arterial pressure (r = -0.308, n = 104 “P-value” < 0.01) which was statistically

significant. A Wilcoxon-signed rank test showed that the increase in Perfusion index was noted after the administration of oxytocin (Z = -4.300, "P-value" < 0.01) and decrease in PI observed following ephedrine injection(Z= -2.632, "P-value" <0.01) which were statistically significant .

Conclusion: Perfusion index as such alone can be used as a predictor of maternal hypotension following spinal anaesthesia during elective caesarean section. Moreover, the perfusion index can also be used as a means to assess the response of ephedrine boluses and can help the anesthesiologist decide on further boluses of ephedrine. the perfusion index can also help to assess the degree of hypotension which comes upon the administration of oxytocin.

Keywords: Caesarian section. Pulse oximeter, vasopressor, oxytocin

INTRODUCTION

In modern practice, spinal anaesthesia is currently the most preferable route of anaesthesia in parturient undergoing caesarean section whether as an elective or emergency. Hypotension, being the most dreaded consequence of spinal anaesthesia, if severe and sustained, may impair the uteroplacental circulation, resulting in unfavorable maternal and foetal outcomes. Adverse maternal and foetal outcome includes hypoxia, acidosis , altered consciousness and cardiac arrest. Oxytocin is a natural hormone given intravenously soon after delivery which causes uterine contraction and hypotension. Therefore, prevention and treatment of spinal hypotension have been a key research area within the field of obstetric anesthesia. [(1)]

Safe anesthesia could be provided if timely detection of hypotension were to be carried out as well as the initiation of appropriate and prompt treatment for the very same. Over the years, many strategies have been employed to prevent or treat hypotension. The concepts of fluid loading vs co-loading, whether with colloids or crystalloids, have been topics of discussion for many decades. After many studies, it was found that co-loading is more

effective. [2] Similarly, the use of vasopressors and the vasopressors of choice have been hot topics of discussion.[2] The post spinal hypotension arises due to the blockade of the sympathetic nerve fibres which controls vascular smooth muscle tone. During pregnancy, there is an increased sensitivity of the nerve fibers to local anesthetics and a general decrease in responsiveness to vasopressors. Both of these conditions increase the probability of the parturients in developing profound hypotension following subarachnoid blockade (SAB) caesarean section . Non-invasive blood pressure (NIBP) measurement is accepted as the standard hemodynamic monitoring modality inside the operation theatre.[3] However, the NIBP might not be able to perceive hypotension in a timely manner. This method cannot measure beat-to-beat variation in perfusion dynamics which limits its efficacy. There are various other non-invasive methods which can eventually be used to predict hypotension. However, not all settings have the luxury of having such monitors except for pulse oximeters which are available but under- shadowed. This study aims to shed more light on this simple monitor, which has functions other than just reading out the saturation.

Ratio of pulsatile blood flow to non-pulsatile blood flow in the peripheral vascular tissue, measured using a pulse oximeter is called perfusion index(PI) and it is based on the amount of infrared light absorbed. Its values range from 0.02% for a very weak pulse to 20% for an extremely strong pulse." [4]Hence, PI is being regarded as a new non-invasive monitoring aid for the timely detection of hypotension post subarachnoid block (SAB).

Numerous studies have been conducted where the perfusion index has been used to assess haemodynamics. However, there is still inadequate information regarding its use as a tool for predicting the incidence of hypotension which occurs due to central neuraxial blockade.

Primary aim of the study was to establish whether the trend in the perfusion index (PI) detects hypotension before the changes in non-invasive blood pressure (NIBP) values and to evaluate the effect of oxytocin infusion on PI during elective lower-segment caesarean sections under spinal anaesthesia.

MATERIALS AND METHODS

Longitudinal prospective observational study was conducted in tertiary care Centre in parturients aged between 20 and 35 years , Singleton term pregnancy belong to ASA II who are planned for elective caesarean section under spinal anesthesia were included in our study group. Pregnant women who did not give consent for the study, with age > 36 years or > 40 weeks of gestational age, short stature, associated medical or obstetric comorbidities were excluded from the study. The study was conducted in our teaching hospitals from November 2020 after the approval of the Institutional Ethics Committee till June 2022 . sample size was calculated by $\mathbf{n=Z^2\sigma^2/d^2}$= 104 ,where, *Z = 1.96, a standard normal value at a 5% level of significance,* σ^2*, SD = 2.60622 [2] d =Margin of Lewis =5% with a 95% Confidence interval and 80% Power, the minimum number required for the study was 104. Proforma was used to collect data following* convenience non-probability sampling. Microsoft Excel was used to enter the data.

Data analysis was carried out with Microsoft Software SPSS® version 25 (IBMTM) using Spearman's Correlation with Mean and Standard Deviation. Correlation and simple linear regression analysis were also done. The Wilcoxon-signed rank test was also used to determine the effect of ephedrine bolus and oxytocin infusion on perfusion index. In this study P value was defined as being less than 0.01 ("P value"<0.01) which was regarded as statistically significant.

METHODOLOGY

The data collection was started in those parturients satisfying the previously mentioned inclusion and exclusion criteria.

Detailed pre-anaesthetic evaluation and investigations were done as per the institutional protocol before the surgery. A 16–18-gauge intravenous cannula was secured for fluid and drug administration. Aspiration prophylaxis comprising of a combination of Injection ranitidine 50mg and Injection metoclopramide 10 mg intravenously was given as a slow bolus to all patients at least 30 minutes before the surgery. Each parturient was given a rapid intravenous infusion of 15 ml/kg of Ringer's lactate intravenous fluid as co-loading during the spinal block and continued until the end of the surgery.

Standard Monitors which were connected for pre procedural values and intraoperative monitoring purpose. The pulse oximeter probe was always attached to the left index finger of all parturients, to ensure uniformity in measured PI values. The cuff of the automated NIBP device and Intravenous fluid was attached to the right arm of the patient. The following parameters like SBP(systolic blood pressure), DBP(diastolic blood pressure), MAP (mean arterial pressure),HR(heart rate), and SPO2(oxygen saturation), PI (perfusion index) and respiration were recorded in a supine position with a 15° table tilt, achieved using a wedge:

Spinal anaesthesia was performed under strict aseptic precautions, in the left lateral position or sitting position. Using a 25-gauge Quincke Babcock's needle, 10 mg of 0.5% hyperbaric bupivacaine solution was injected into the subarachnoid space at L_3-L_4 or L_4-L_5 intervertebral disc space. Immediately after spinal anaesthesia, the patient was returned to the supine head-up position with a left lateral table tilt of 15°.After 5 minutes of spinal anaesthesia, the sensory level was checked by assessing the sensation with a cold swab. The goal was to achieve a sensory block up to $T_{4\text{-}6}$ level. After a waiting period of ten minutes post-SA, the level of the block was evaluated, if it were to be lesser or greater than $T_{4\text{-}6}$, then those parturients were excluded from our study. The seven parameters mentioned above were recorded every minute till the delivery of the baby. As soon as the baby was delivered, oxytocin 20 international units (IU) were started as an intravenous infusion in 500ml Ringer's lactate solution as part of the active management of the third stage of labour . Those parturients necessitating supplementary oxytocin and/or requiring any extra surgical procedures were omitted from the study. Measurements of the parameters were then taken at 3 minutes intervals till the end of the operation."A decrease in SBP 20% from the baseline or SBP less than 100 mmHg was defined as hypotension for this study." [(5)]

Vasopressors were administrated to keep the blood pressure at a normal during the caesarean section while maintaining a target SBP of not less than 20% from the initial starting value. Ephedrine is conventionally given as a rescue drug in post-spinal hypotension, although this study only included those patients' receiving ephedrine as a rescue drug without interrupting the attending anaesthetist's management. Patients requiring additional vasopressors other than ephedrine

were excluded from the study. Post - SA, the first 60 minutes were taken as an anaesthesia-induced hypotension period. A heart rate of fewer than 60 beats per minute was taken as bradycardia, which was managed by administrating an injection of 0.6mg of atropine as an IV bolus. If oxyhaemoglobin saturation became less than 95%, 5-6 litres of oxygen per minute were given via Hudson's facemask. The occurrence of any other adverse effects such as nausea, vomiting, etc. if ever observed were documented and managed accordingly.

RESULTS

- Demographic features like age, patients height and weight were comparable between two groups.
- The mean values of SBP vis-à-vis PI were plotted and Spearman's correlation was carried out. It was found that there is a small negative linear correlation between SBP and PI as demonstrated by the simple scatter plot.

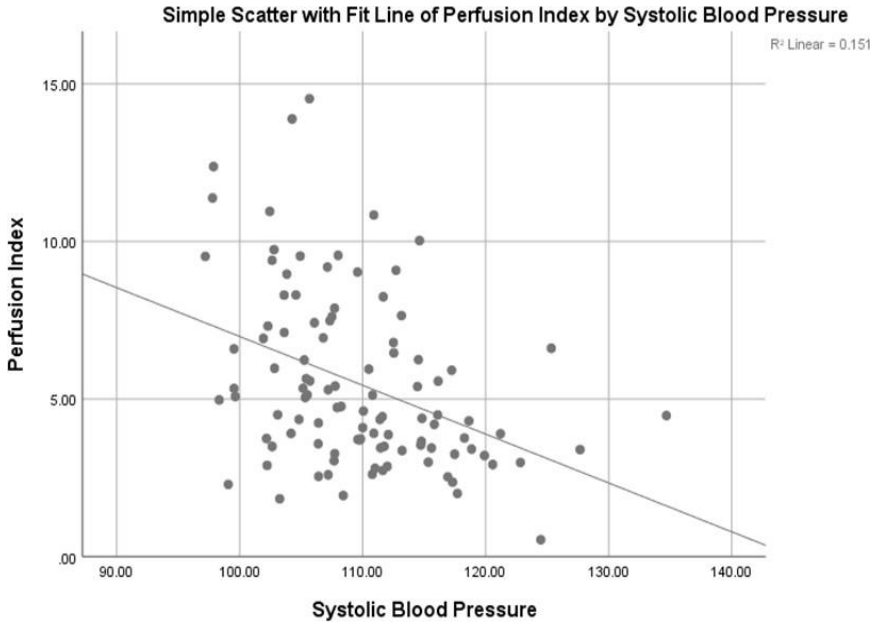
  Moreover, the correlation was statistically significant since the P value was 0.00 (''P Value'' < 0.01). **(FIG- 1)**
- The mean values of MAP with PI were also plotted and analysed using Spearman's correlation. There is a low negative correlation between MAP and PI.

  This correlation was also statistically significant, P value being 0.001 (" P value"< 0.01). **(FIG- 2)**
- Upon analysis with the Wilcoxon-signed rank test for values of PI before and after oxytocin administration, the test showed that the increase in PI after the administration of oxytocin was statistically significant (Z = -4.300, "P value" < 0.01). The Median PI value was 4.9450 after the administration of oxytocin compared to the median PI value of 4.3000 without the administration of oxytocin. **(TABLE- 1)**
- Wilcoxon-signed rank test was also done whenever hypotension was managed with

ephedrine. The median values of SBP and PI before and after the administration of ephedrine were analyzed. It was found that the median SBP value after ephedrine was 104.7 compared to the median SBP value of 91.5 before ephedrine administration, which was statistically significant (Z = -7.229, "P value" < 0.01).

- Also, the decrease in PI after the administration of ephedrine was statistically significant, (Z = -2.63, "P value"< 0.01). The median PI value before ephedrine was 7.47 compared to the median PI value of 6.76 before ephedrine administration.

FIGURE 1: CORRELATION BETWEEN SYSTOLIC BLOOD PRESSURE AND THE PERFUSION INDEX



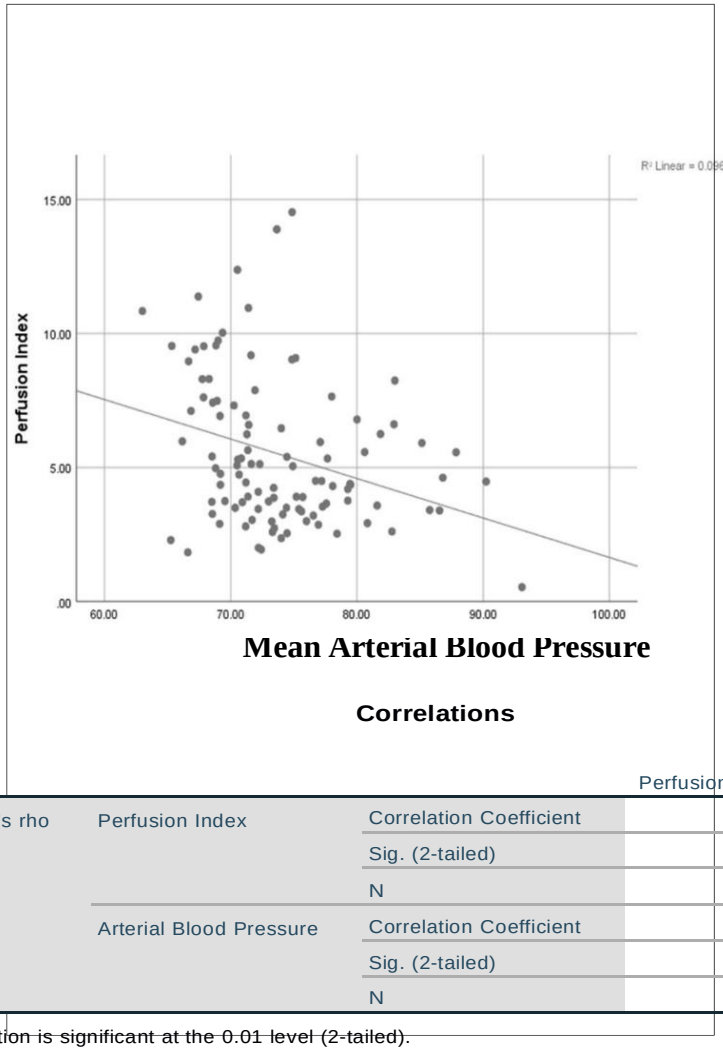
Correlations

			Perfusion Index	Systolic Blood Pressure
Spearman's rho	Perfusion Index	Correlation Coefficient	1.000	-.397**
		Sig. (2-tailed)	.	.000
		N	104	104
	Systolic Blood Pressure	Correlation Coefficient	-.397**	1.000
		Sig. (2-tailed)	.000	.
		N	104	104

**. Correlation is significant at the 0.01 level (2-tailed).

FIGURE 2: CORRELATION BETWEEN MEAN ARTERIAL BLOOD PRESSURE AND PERFUSION INDEX

Simple scatter with fit line of Perfusion Index with Mean arterial blood pressure



Correlations

			Perfusion Index	Arterial Blood Pressure
Spearman's rho	Perfusion Index	Correlation Coefficient	1.000	-.308**
		Sig. (2-tailed)	.	.001
		N	104	104
	Arterial Blood Pressure	Correlation Coefficient	-.308**	1.000
		Sig. (2-tailed)	.001	.
		N	104	104

**. Correlation is significant at the 0.01 level (2-tailed).

TABLE 1: WILCOXON-SIGNED RANK TEST FOR PERFUSION INDEX BEFORE ANDAFTER OXYTOCIN INFUSION

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum	Percentiles 25th	50th (Median)	75th
PI before oxytocin	104	4.7991	2.60236	.62	15.85	3.1470	4.3000	6.2
PI after oxytocin	104	5.9751	3.30632	.45	16.69	3.4400	4.9450	7.6

Ranks

		N	Mean Rank	Sum of Ranks
PI after oxytocin - PI before oxytocin	Negative Ranks	35[a]	40.11	1404.00
	Positive Ranks	69[b]	58.78	4056.00
	Ties	0[c]		
	Total	104		

a. PI after oxytocin < PI before oxytocin

b. PI after oxytocin > PI before oxytocin

c. PI after oxytocin = PI before oxytocin

Test Statistics[a]

	PI after oxytocin - PI before oxytocin
Z	-4.300[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

DISCUSSION

While taking into consideration the various side effects of maternal hypotension during spinal block, various other options of predicting hypotension must be kept open. The reliability should not always be on the NIBP, which on its own might be easy to use but does not have the real-time beat- to-beat variation and hence creates a time lag phase. This could mean a delay in the recognition, prevention and treatment of hypotension. Various methods are available for predicting the risk of hypotension following spinal anaesthesia like heart rate variability, skin conductance, plethysmography- variability index, sensory block level and bioimpedance-based hemodynamic monitoring and even perfusion index.[(2)]

In this study, we chose to see how the perfusion index predicts maternal hypotension. This study specifically focuses on PI as most of the pulse oximeters are equipped with this feature, available in most health care setups in India, but unfortunately not given its required importance as a monitoring aid, hence not commonly used.

Perfusion Index (PI) is a non-invasive parameter which is based on the principle of absorption of two lights at different wavelengths resulting in a fraction of pulsatile (arterial blood) to non-pulsatile (tissue) components .[(6)]

During pregnency, there is a general drop in systemic vascular resistance, and increase in the total blood volume and cardiac output which eventually results in a decrease in systemic vascular resistance and hence a decrease in peripheral vascular tone. PI, corresponds to peripheral perfusion, which is undoubtedly affected by peripheral vascular tone. As the tenor of these blood vessels decreases, this subsequently leads to an increase in the perfusion index as there is an associated rise in the pulsatile components following vasodilatation. Whenever neuraxial anaesthesia is given, the sympathectomy caused by it

will cause a further decrease in the tone of the blood vessels' wall. This results in an increased pooling of blood and hence hypotension, reflecting even higher PI values. Other studies showed that a baseline PI > 3.5 correlates well with hypotension and can be considered a fair predictor of hypotension following spinal anesthesia. [7,6,8] One study, however by M Yokose et al [9] did not conclude the same. It might be due to various limitations in terms of different methodological approaches and external factors which had led to the same. Our study was not based on the baseline perfusion index, instead, we decided to analyse serial blood pressure readings and that of the perfusion index to find a correlation. A similar study was based on the same analytical principle which was done by Mallawaarachchi et al [5] and focused on the serial changes in SBP, and MAP with that of PI. No other studies have analyzed it in the same manner. Although the study of Mallawaarachchi et al [5] showed a lot of variation between the timing and degree of change in PI amongst the parturient, it was observed that PI tends to rise sooner in those women with substantial hypotension. This might be because of the effect of spinal anaesthesia on the sympathetic nervous system. On Pearson correlation, a statistically significant association was found between an increase in perfusion index and hypotension ($p < 0.01$)."The thoracic sympathetic blockade is known to increase PI in the fingers"[10] In other studies dealing with peripheral nerve blocks, even the brachial plexus block demonstrated an increase in PI in the blocked arm. [11,12] Our study showed that there is a small negative correlation between both serial SBP and PI & MAP and PI, both being significant markers of hypotension, the results being significant in both cases ($p<0.01$) upon Spearman's correlation. In another study[6], it was shown that the starting PI value of more than 3.5 and the number of episodes of hypotension are strongly correlated with each other and more so statistically significant. It was even found that as the baseline PI was higher than the stipulated value, the amount of intravenous fluids used as well as the

quantity of vasopressors required also increased concomitantly. Those parturients with baseline PI > 3.5 necessitated a larger number of vasopressors. In our study, PI also correlated well before and after the administration of ephedrine bolus during hypotension (p=0.00). This can further be used as a guide on the number of additional vasopressors to be used. In contrast, the study carried out by Yokose et al [(9)]established the fact that PI cannot be used as a prognostic value for hypotension in a similar context. This inconsistency was attributed to the difference in the methodologies, like the definition of various terminologies such as hypotension, co-loading with colloids and the methods used for calculating baseline PI. Mallawaarachchi et al [(5)]) concluded that the effect on the vascular tone by oxytocin 5IU bolus is significant although it does not cause significant hypotension ($p<0.01$). Our study also showed an increasing trend of PI after starting of oxytocin infusion (20 IU) which depicts hypotension ($p< 0.01$). A lot more studies need to be carried out before PI can be accepted as a universal non-invasive tool to predict hypotension following spinal anaesthesia. In addition, further studies comparing PI with other non-invasive and accepted tools of haemodynamic monitoring may throw more light on its utility. The PVI which is a non-invasive and continuous measure of the active change in perfusion index might also be considered. [(13)] Bioreactance-based non-invasive cardiac output [(2)] monitoring can also be taken into consideration as it has fewer adverse effects associated with body movements and does not require any arterial cannulation. However, it might not be available in all setups.

CONCLUSION

Perfusion index as such alone can be used as a predictor of maternal hypotension following spinal anaesthesia during elective caesarean section. Moreover, the perfusion

index can also be used as a means to assess the response of ephedrine boluses and can help the anesthesiologist decide on further boluses of ephedrine or any other vasopressors.

Since there is a significant effect after the administration of oxytocin on the perfusion index, the perfusion index can also help to assess the degree of hypotension which comes upon the administration of oxytocin.

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Abbreviations

1. P I = Perfusion index
2. SAB =Sub arachnoid block
3. NIBP= Non-invasive blood pressure
4. LSCS= Non-invasive blood pressure
5. H R= Heart rate
6. SBP= Systolic blood pressure
7. DBP= Diastolic blood pressure
8. Spo2= Oxygen saturation
9. MAP= Mean arterial pressure

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