

Perfusion Index as an Early Predictor of Hypotension Following Spinal Anesthesia for Cesarean Section

Abstract

Introduction: Hypotension is a common complication after spinal anesthesia for cesarean delivery which is caused by sympathetic block 1. This can result in adverse maternal and fetal outcomes. Hence prevention and early treatment of spinal hypotension early has been a key research area in obstetric anesthesia. Intermittent non-invasive blood pressure measurement is the standard practice that fails to detect episodes of hypotension in a timely fashion. **Methods:** Noninvasive PI and blood pressure were measured in 109 healthy parturients undergoing elective cesarean section under spinal anesthesia. **Results:** PI appeared to increase significantly and more quickly in parturients with significant hypotension. **Discussion:** Findings may be due to the thoracic sympathetic blockade. **Conclusion:** Perfusion index can be a useful tool to early predict hypotension following spinal anesthesia for cesarean section. Response to ephedrine can be quickly assessed by the change in the PI which helps to decide on further boluses of ephedrine. Effect on the vascular tone by oxytocin is significant with 5IU bolus, though it does not cause a significant blood pressure drop.

Keywords: Anesthesia, hypotension, obstetric, perfusion index, plethysmography, pulse oximeters, subarachnoid complications

Introduction

Spinal anesthesia is the popular route of anesthesia in parturients for caesarean delivery.^[1] Hypotension is a common complication after spinal anesthesia which can result in adverse maternal and fetal outcomes. Hence, prevention and treatment of spinal hypotension have been a key research area in obstetric anesthesia.

In addition the ability to identify hypotension early would enable anesthetists to initiate appropriate treatment, such as the early initiation of vasopressors. Noninvasive blood pressure measurement (NIBP) which is intermittent is the standard practice to measure blood pressure during cesarean section. However, this may fail to detect episodes of hypotension in a timely fashion.

Perfusion Index or PI is the ratio of the pulsatile blood flow to the non-pulsatile static blood flow in a patient's peripheral tissue such as in a fingertip, toe, or ear lobe. This can be obtained from a pulse oximeter. This is non-invasive and continuous monitoring. The degree of hypotension is due to vascular tone. PI can be used to

access the peripheral perfusion which can be altered due to peripheral vascular tone.^[2] The PI's values range from 0.02% for a very weak pulse to 20% for an extremely strong pulse.

Previous research done on the incidence of hypotension during spinal anesthesia for cesarean delivery suggests a perfusion index of >3.5 predicts the likelihood of hypotension during spinal anesthesia for cesarean section.^[3]

Methods

The Main objective of this study was to establish whether the trend of the perfusion index detects hypotension before the changes in NIBP values and to find the effect of the oxytocin bolus to the perfusion index and the effect of the IV ephedrine bolus during hypotension on perfusion index and evaluating the response to ephedrine using the PI.^[4,5]

In total, 109 pregnant mothers undergoing an elective cesarean section with an ASA status of 1 and 2 with a singleton fetus were included in this study. Emergency cases, morbid obesity with a BMI of more than 40, period of gestation less than 36 or more than 41, any cardiac pathology and obstetric

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Received : 12-Jul-2018
Revision : 19-Dec-2018
Accepted : 10-Nov-2019
Published : 11-Mar-2020

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Access this article online

Website: www.joacc.com

DOI: 10.4103/joacc.JOACC_39_18

Quick Response Code:



How to cite this article: Mallawaarachchi RP, Pinto V, De Silva PH. Perfusion index as an early predictor of hypotension following spinal anesthesia for cesarean section. *J Obstet Anaesth Crit Care* 2020;10:38-41.

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complications including IUGR were excluded from this observational study. Informed written consent was obtained.

According to current recommendation, each woman was given a rapid intravenous infusion of 500 ml of normal saline started as co-loading during the spinal block and continued until the end of the surgery.^[6,7] Volume for each parturient was a fixed amount. ECG, pulse oximetry, non-invasive blood pressure were continuously monitored. Cuff of the automated NIBP device was attached to the right arm and the pulse oximeter probe was attached to the left hand. In supine and 15° table tilt position baseline SBP, DBP, MAP, heart rate, and perfusion index were recorded.

Spinal anesthesia was performed in the sitting position at L4-5 or L3-4 interspace. Following regime (145 cm – 149 cm: 2 ml, 150 cm – 154 cm: 2.3 ml, 155 cm – 160 cm: 2.4 ml, 160 cm above: 2.5 ml) was used to decide the 0.5% heavy bupivacaine dose which was injected to intrathecal space with 15 micrograms of fentanyl. The total volume was given according to the height.

Immediately after the spinal anesthesia, the parturient was returned to the supine head up position with a left lateral table tilt of 15°.

Table tilt of 15° was measured using an iPhone application known as Surface level- Angle and slope measure tool version 1.3.

After 5 min of the spinal anesthesia sensory level was checked by assessing the cold sensation with ice. Ice cube was applied above the patient’s clavicle as a reference point and then moved continuously cephalad in the mid-clavicular line to check the dermatome level. The goal was to achieve a sensory block up to T4. This was achieved by the reverse trendelenburg position. If it was lower or higher after 10 min of the spinal anesthesia these mothers were excluded from the study.

Maternal SBP, DBP, MAP, heart rate, and perfusion index were recorded every 1 min until the delivery of the baby. Then until the end of surgery measurements were taken at 3 min intervals.

Decrease in SBP 20% from baseline or SBP less than 100 mmHg^[8] was defined as hypotension for this study. Ephedrine was given to maintain arterial blood pressure during the cesarean section to achieve the target. Target was to keep the SBP drop less than 20% of the baseline values. A bolus of atropine 0.5 mg was administered if the hypotension was associated with bradycardia (heart rate less than 60). If oxyhemoglobin saturation became less than 95%, oxygen was given via a Hudson facemask.

Data analysis

Data was analyzed using SPSS statistical software version 22.0.0.0 to see whether the trend of perfusion index has a relationship with the hypotension. This was

analyzed by using the Pearson product-moment correlation coefficient (Pearson’s correlation) which measures the strength and direction of association that exists between two variables measured, perfusion index and hypotension respectively in our study.

Results

None of the parturients presented a low signal quality that was inadequate for measuring PI. The analysis was from the 109 data sets. On average, PI values rose more rapidly for the patients who experienced hypotension. Pearson Correlation revealed that the PI correlated with the decreases in systolic and mean arterial pressure. Correlation is significant at the 0.01 level (2-tailed) [Table 1 and Figure 1].

Patients who have treated with IV Ephedrine bolus showed a significant difference ($P < 0.001$) between PI before and after giving the ephedrine bolus. The Pearson correlation for this was 0.378 [Table 2].

Table 1: Correlations between the systolic blood pressure and perfusion index. Data are determined by Pearson correlation

Descriptive Statistics			
	Mean	Std. Deviation	n
Systolic BP	111.64	22.685	483
Perfusion index	4.1729	2.60627	480

n = Total number of entries of all the patients

Correlations			
		Systolic BP	Perfusion index
Systolic BP	Pearson Correlation	1	-0.236**
	Sig. (2-tailed)		0.000
	n	483	480
Perfusion index	Pearson Correlation	-0.236**	1
	Sig. (2-tailed)	0.000	
	n	480	480

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

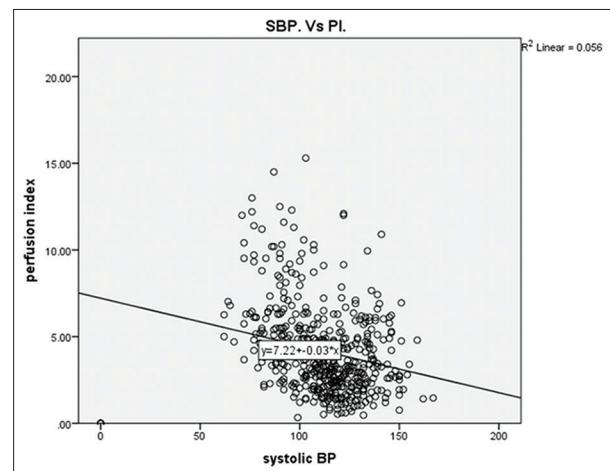


Figure 1: The correlation between PI and the degree of decrease in systolic blood pressure during spinal anaesthesia for Caesarean delivery

Table 2: Correlations between the blood pressure variables and perfusion index following oxytocin bolus

Paired Samples Correlations			
	<i>n</i>	Correlation	Sig.
Pair 1			
Before SBP and After SBP	29	0.380	0.042
Pair 2			
Before DBP and After DBP	29	0.246	0.199
Pair 3			
Before MAP and After MAP	29	0.378	0.043
Pair 4			
Before PI and After PI	29	0.798	0.000
There is a significant ($P < 0.001$) increase in PI following the 5IU bolus of oxytocin			
Paired Samples Correlations			
	<i>n</i>	Correlation	Sig.
Pair 1			
Before PI and after PI	109	0.909	0.000

Discussion

In a previous study, the incidence and severity of hypotension, vasopressor requirement was higher in parturients whose baseline PI values were greater than 3.5.^[3] However, the correlation between PI trend and the degree of hypotension during spinal anesthesia has not been studied.

Hypotension following administration of spinal anesthesia for cesarean delivery is common. There is no definite monitoring system that may predict the likelihood of developing hypotension so that additional precautions, such as fluid boluses, ephedrine, and head-up position may be taken.

The principle of SpO₂ is depending on two light sources with different wavelengths 660 nm and 940 nm, emitted through cutaneous vascular bed of finger or earlobe. The absorbance of both wavelengths has a pulsatile component, which represents fluctuations in the volume of arterial blood between the source and the detector. The non-pulsatile component is from connective tissue, bone, and venous compartment. The perfusion index is the ratio of the pulsatile component (arterial) and a non-pulsatile component of light reaching the detector.

A healthy pregnancy is characterized by a decrease in systemic vascular resistance, increased total blood volume, and cardiac output.^[9] The reduction of systemic vascular resistance may vary in parturients depending on various factors. This decrease in tone will correspond to higher perfusion index values due to an increase in pulsatile component due to vasodilatation. Induction of sympathectomy by spinal anesthesia will cause a further decrease in peripheral vascular tone and increase pooling and hypotension. Ginosar *et al.* demonstrated that an increase in PI following epidural anesthesia was a clear and reliable indicator of sympathectomy.^[10]

The cut-off value of baseline perfusion index for prediction of hypotension following spinal anesthesia was chosen as 3.5 from a study conducted by Toyama *et al.*^[3] who did regression analysis and ROC curve analysis and concluded that a baseline perfusion index cut-off point of 3.5 could be used to identify parturients at risk for such hypotension. Toyama's study, only the baseline value was considered for analysis, because they did not try to explore the correlation between changes in serial PI values with the incidence of hypotension.

Timing and degree of change in PI varied widely between patients in our study. It did not demonstrate the potential to inform management of blood pressure. PI appeared to increase higher and more quickly in women with significant hypotension suggesting that spinal anesthesia may have developed more quickly in these cases. The thoracic sympathetic blockade is known to increase PI in the fingers.^[11] Brachial plexus block has been shown to increase PI in blocked arm. During SA, the level of sympathetic block is several segments higher than the sensory block.^[12] In our patients, the raised PI post spinal anesthesia is likely due to vasodilatation from sympathetic blockade of the hand. On Pearson correlation, a highly significant correlation was found between increase in perfusion index and the hypotension.

There are many limitations in this study. Patient movement and any stimulus increasing sympathetic activity like anxiety could easily change the PI values. In this study, we recorded baseline PI values with utmost care to avoid patient movement, especially while recording baseline values and all patients were counseled before taking them up for surgery to allay anxiety. We measured the baseline values in left lateral tilt position to avoid the effect due to aortocaval compression in the supine position while recording.

Because 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 non-invasive tool to predict hypotension following spinal anesthesia. In addition, further studies comparing PI with invasive and accepted tools of hemodynamic monitoring may throw more light regarding its utility.

Conclusion

Perfusion index appeared to increase significantly and more quickly in parturients with significant hypotension. This may be due to the thoracic sympathetic blockade. Response to ephedrine can be quickly assessed by the change in the PI which helps to decide on further boluses of ephedrine. Effect to the vascular tone by oxytocin is significant with 5IU bolus, though it does not cause a significant blood pressure drop.

Financial support and sponsorship

This study was attributed to Department of Anaesthesiology, Teaching Hospital Peradeniya, Sri Lanka. Support was provided solely from hospital sources.

Conflicts of interest

There are no conflicts of interest.

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