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Can a perfusion index, measured by pulse oximeter predict hypotension following spinal anesthesia in healthy parturients undergoing elective lower segment cesarean section?

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Abstract

Background: Hypotension is a common complication following spinal anesthesia (SA) for lower segment cesarean section (LSCS) which has detrimental effects both on mother and fetus. This study is aimed at investigating the correlation between baseline perfusion index (PI) and incidence of hypotension following SA for parturients undergoing LSCS.

Methods: 60 parturients were divided into two groups of 30 patients each on the basis of baseline PI. Parturients with baseline PI ≤ 3.5 and > 3.5 were added in Group I and Group II respectively. SA was performed with 2ml (10 mg) of injection 0.5% hyperbaric bupivacaine at L3–L4 or L2–L3 inter-space. Hypotension was defined when the mean arterial pressure falls below 65 mmHg which was treated with IV fluid boluses and vasopressors.

Results: There was no significant correlation between baseline PI (> 3.5 and ≤ 3.5) and incidence and severity of hypotension ($p > 0.05$).

Conclusion: Parturients with baseline PI > 3.5 were not at higher risk of developing hypotension following spinal anesthesia compared to those with baseline PI ≤ 3.5 .

Keywords: Hypotension, perfusion index, pregnancy, cesarean section, spinal anesthesia

Introduction

LSCS is commonly performed under spinal anesthesia. Hypotension following administration of spinal anesthesia for LSCS is common. This hypotension may cause severe adverse effects in mothers and in infants [1].

Parturients have low mean arterial pressure (MAP) at term, are less responsive to vasopressors, and are more sensitive to local anesthetic agents. Hence, parturients can develop profound hypotension following SA for LSCS [2].

The present study was undertaken to determine whether a baseline PI value > 3.5 predicts the development of hypotension after spinal anesthesia in healthy parturients undergoing elective LSCS.

Materials and Methods

After Institutional Ethics Committee (IEC) approval, a prospective, observational study was done in 60 healthy parturients aged between 20 and 35 years of age with American Society of Anesthesiologists (ASA) grade I and II undergoing elective LSCS under spinal anesthesia from August 2018 to January 2019 in our institute. An informed written consent was taken from all the patients under this study. We hypothesized that parturients with higher baseline PI (PI > 3.5) would have a higher incidence of hypotension following SA.

Parturients with gestational age between 36–41 weeks, undergoing elective LSCS, ASA grade I and II and BMI ≤ 40 kg/m² were included in this study. Parturients with placenta previa, pre-eclampsia, cardiovascular or cerebrovascular disease, gestational diabetes mellitus, morbid obesity, contraindications to SA, refusal for SA, requiring additional oxytocic's and/or additional surgical interventions, in whom sensory block at T6 level was not attained were excluded in this study.

All patients were kept Nil by Mouth (NBM) for 6 to 8 hrs. On the day of surgery, on arrival in the operating room, NBM status and Consent was confirmed.

Monitors viz, Electrocardiogram (ECG), Non-Invasive Blood Pressure (NIBP), Pulse Oximeter were attached and the baseline values of heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), MAP, saturation (SpO₂), ECG. With the patient in supine position perfusion index was measured by attaching the Masimo SET (Signal Extraction Technology) pulse oximeter (Masimo Corp., Irvine, CA, USA) to the index finger of the left hand.

In both groups, intravenous (IV) line was secured using 18G cannula in left upper limb and pre-loaded with 500ml of Ringer Lactate over 20 minutes. The baseline PI values were recorded after pre-loading the parturients. Those with a baseline perfusion index of ≤ 3.5 were taken as Group I and those with a perfusion index of >3.5 were taken as Group II. Spinal anesthesia was given using Quincke's 25-gauge spinal needle in sitting position with 2ml (10mg) of injection 0.5% hyperbaric bupivacaine at L3–L4 or L2–L3 interspace. The parturients were returned back to the supine position from sitting position with a left lateral tilt of 15° to facilitate the left uterine displacement. Oxygen was administered through the face mask at flows of 5 L/min. Ringer's lactate was administered at a maintenance rate of 100ml/10min after pre-loading throughout the surgery.

The level of sensory blockade was checked 5 min after the spinal anesthesia with a cold swab. Maximum level of sensory blockade was checked 20min after SA. If T6 level of sensory blockade was not achieved, the parturients were excluded from the study and were managed as per our institutional protocol. HR, SBP, DBP, MAP and SpO₂ were recorded at 2 min intervals after the SAB up to 20 min and then at 5 min intervals till the end of surgery.

Hypotension was defined in our study as a fall in the MAP below 65 mm of Hg and was treated with IV Bolus of Injection Mephentermine 6mg and IV bolus of 100 ml Ringer lactate. APGAR score of babies were recorded at 1st and 5th mins of birth. Injection Oxytocin 20 units was given as uterotonic following delivery of baby at a rate of 200 mU/min as a separate infusion. If Patients required additional oxytocic's and/or additional surgical interventions we excluded them from our study. The incidence of side effects were recorded.

Results

A total of 60 parturients were included in our study. No participants were excluded from our study.

The demographic parameters such as age, height, weight and BMI were comparable in each group. [Table 1]

Table 1: Comparison of demographic characteristics between two groups

Demographic Parameters	Group I (n=30) PI ≤ 3.5	Group II (n=30) PI > 3.5	P value (Test)
Age in years (mean \pm SD)	27.83 \pm 3.70	28.06 \pm 4.20	0.80 (un-paired t test)
Height in cm (mean \pm SD)	150.43 \pm 4.006	150.46 \pm 6.39	0.98 (un-paired t test)
Weight in kg (mean \pm SD)	61.16 \pm 10.33	61.93 \pm 11.49	0.76 (Mann Whitney test)
BMI in kg/m ² (mean \pm SD)	26.97 \pm 3.97	27.35 \pm 4.30	0.71 (un-paired t test)

The median level of sensory block achieved in both groups was T6. Baseline heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressures were

also comparable between the two groups.

The difference in average PI in group I and in group II was statistically significant (P 0.0002). [Table 2]

Table 2: Comparison of Average PI between two groups

Groups	Average PI	P value (Test)
Group I (n=30) PI ≤ 3.5 (mean \pm SD)	2.04 \pm 0.89	0.0002 (Mann Whitney Test)
Group II (n=30) PI > 3.5 (mean \pm SD)	7.42 \pm 3.64	

The difference between the two groups with respect to heart rate and diastolic blood pressure was not statistically significant. [Figure 1] and [Figure 3]

The difference in the systolic blood pressure between the two groups was not statistically significant except at 30th

and 35th minute with P values 0.02 and 0.03 respectively, the difference in the mean arterial pressure between the two groups was not statistically significant except at 30th and 45th minute with P values 0.04 and 0.01 respectively. [Figure 4] and [Figure 2]



Fig 1: Comparison of Heart Rate between Two Study Groups

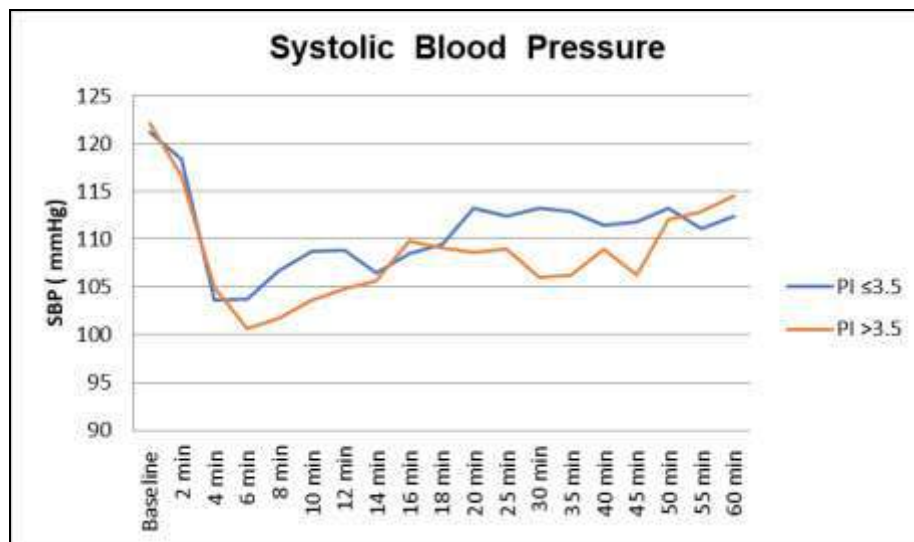


Fig 2: Comparison of Systolic Blood Pressures between Two Study Groups

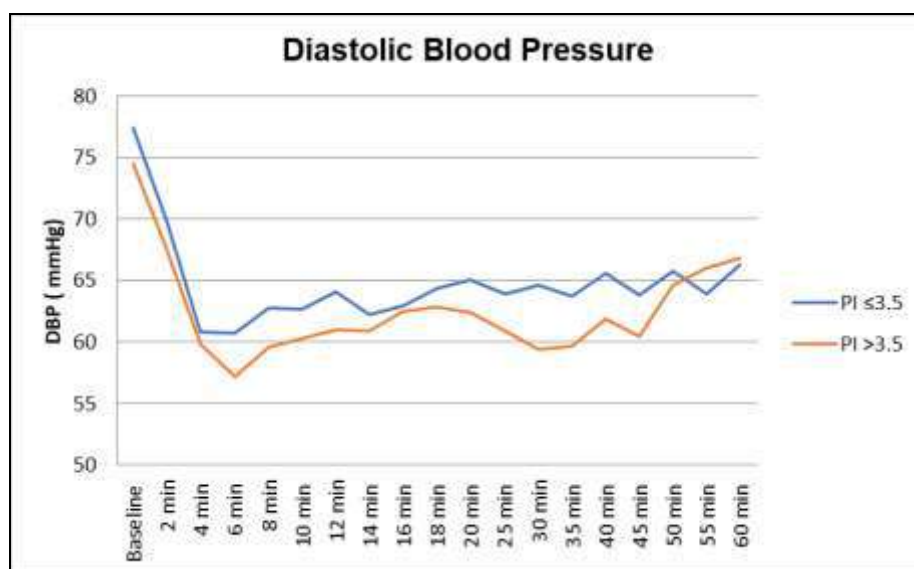


Fig 3: Comparison of Diastolic Blood Pressures between Two Study Groups

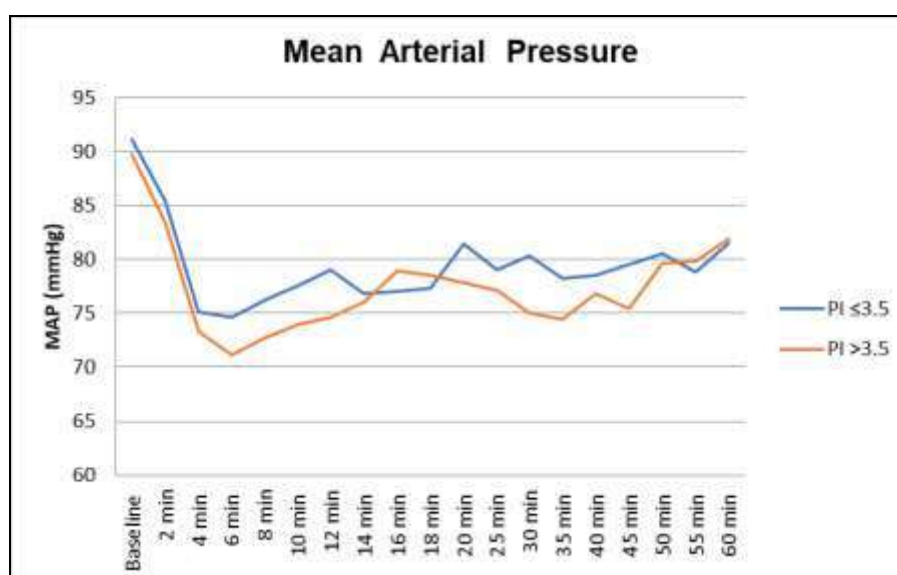


Fig 4: Comparison of Mean Arterial Pressures between Two Study Groups

The total IV fluid boluses requirements and the total Mephentermine requirements were almost same in group I

as well as group II. [Table 3].

In Group I and II, 24/30 and 22/30 patients developed

hypotension the difference was not statistically significant (P 0.76). And, the incidence of hypotension between two

groups was not statistically significant. (P 0.76). [Table 3]

Table 3: Table showing average requirements of Mephentermine, intravenous fluid boluses and incidence of hypotension between two groups

Parameter	Group I (n=30) PI \leq 3.5	Group II (n=30) PI > 3.5	P value
Average dose of Mephentermine in mg (mean \pm SD)	16.6 \pm 3.06	14.2 \pm 2.15	0.75 (Mann Whitney Test)
Average IV fluid Boluses in ml (mean \pm SD)	110 \pm 14.48	116.66 \pm 20.25	0.61 (Mann Whitney Test)
Incidence of Hypotension (%)	80%	73.33%	0.76 (Mann Whitney Test)

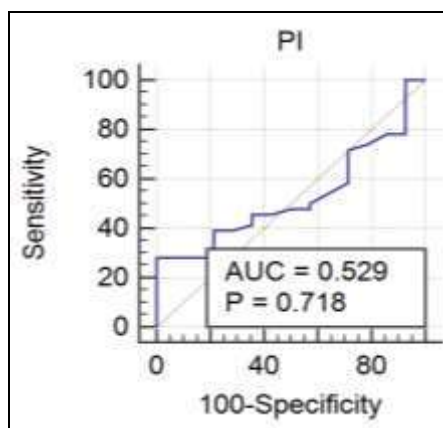


Fig 5: ROC Curve

The sensitivity and specificity of cut-off value 3.5 was found to be 47.83 and 42.86 respectively. The area under the ROC curve was 0.529 [Figure 5].

On analysis of ROC curve a new cut-off value of Perfusion Index of about 3.6 was found with maximum sensitivity (47.83) and maximum specificity (50.00).

Incidence of side effects and APGAR scores were comparable between two groups.

In our study we also found significant correlation between BMI of parturients and hypotension i.e. as the BMI increases the chances of developing hypotension increases. [Table 4]

Table 4: Correlation of BMI and Hypotension

	Correlation Coefficient (r)	P value
Correlation of BMI and Hypotension	0.21	0.09

Discussion

In the current study, the IV fluid bolus requirements, vasopressor requirements, incidence and severity of hypotension in both the groups were same. The ROC curve revealed that cut-off PI value of 3.5 was not able to differentiate well between the parturients who developed hypotension versus those who did not. On analysis of ROC curve a new cut-off PI value of 3.6 was obtained for predicting hypotension in parturients undergoing cesarean section under SA with maximum sensitivity (47.83) and maximum specificity (50.00).

Perfusion index (PI) is defined as the ratio of pulsatile blood flow to the non-pulsatile blood flow in the peripheral vascular tissue measured by pulse oximetry [3].

The hemodynamic changes in normal healthy pregnancy is characterized by a decrease in systemic vascular resistance, increase in total blood volume and increase in cardiac output [7]. This decrease in systemic vascular resistance during healthy pregnancy will correspond to higher perfusion index values due to increase in pulsatile component due to vasodilatation. Induction of sympathectomy by SA will cause a further decrease in systemic vascular resistance and peripheral vascular tone leading to increased peripheral pooling of blood and hypotension which will also lead to increase in perfusion index due to increase in pulsatile component. Parturients with high baseline perfusion index values are expected to have low peripheral vascular tone and

hence are at higher risk of developing hypotension following SA and vice-versa.

The ability of PI to detect vasoconstriction was demonstrated by Mowafi *et al* in their study detecting intravascular injection of epinephrine containing epidural test dose [4]. Ginosar *et al* in their study showed that increase in PI following epidural anesthesia was clear indicator of sympathectomy [5].

The cut-off value of baseline perfusion index for predicting hypotension following SA was taken as 3.5 based on a study done by Toyama *et al*. [8] and Dugappa *et al*. [9] and from their studies it was concluded that cut-off point of baseline perfusion index of 3.5 can be used to identify parturients at risk for such hypotension. We attempted to study the predictive ability of this value in our study. We only considered the baseline value for analysis, as we didn't try to study the correlation between changes in serial PI values with the incidence of hypotension.

In our study the cut-off value of baseline PI of 3.5 was not able to accurately predict hypotension in the two groups which was correlating with the findings of the study conducted by Yokose *et al*. [10] The sensitivity and specificity of cut-off value of baseline PI of 3.5 for predicting hypotension was 47.83 and 42.86 respectively in our study. While in the study conducted by Dugappa *et al* the sensitivity and specificity of cut-off value of baseline PI of 3.5 was 89.29% and 69.84% respectively. [9] Similarly the

sensitivity and specificity of cut-off value of baseline PI of 3.5 in a study conducted by Toyama *et al* was 81% and 86% respectively ^[8].

In our study we found out a new optimal cut-off value of baseline PI as 3.6 with maximum sensitivity of 47.83% and maximum specificity of 50.00%. while the study conducted by George *et al* found out the optimal cut-off value of baseline PI as 3.6 with a sensitivity of 80% and specificity of 60% ^[11]. Duggappa *et al* found 3.85 as cut-off of baseline PI with sensitivity and specificity of 76% ^[9]. Varghese *et al* found 3.83 as a more appropriate cut-off value with a 86.67% sensitivity and 93.33% specificity, positive predictive value of 92.86% and negative predictive value of 87.5% ^[12].

Conclusion

The parturients with baseline PI > 3.5 were not at higher risk of developing hypotension following SA compared to those with baseline PI ≤ 3.5. So, PI cannot accurately predict hypotension in healthy parturients undergoing elective lower segment cesarean section under spinal anesthesia at cut-off value of baseline PI 3.5. Further studies using 3.6 as a cut-off value of baseline PI and large sample size study may be required to further prove the effectiveness of PI in predicting hypotension in healthy parturients undergoing elective LSCS under SA.

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