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PERFUSION INDEX FROM PULSE OXIMETRY AS A PREDICTOR OF INCIDENCE OF HYPOTENSION FOLLOWING SPINAL ANAESTHESIA WITH LEVOBUPIVACAINE 0.5% (HEAVY) IN LOWER SEGMENT CAESAREAN SECTION.

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ABSTRACT **Background & Aim:** The perfusion index serves as a non-invasive measure of peripheral perfusion, derived from pulse oximetry readings. Hypotension is a common complication following subarachnoid block. It needs early detection and intervention to avoid neonatal poor outcomes. This study was conducted to assess the predictability of incidence of hypotension using baseline PI values. **Method:** This prospective observational double blinded study was conducted in a tertiary teaching hospital in 120 parturients of ASA PS II scheduled for elective caesarean section under spinal anaesthesia. Baseline HR, NIBP, Spo2 and PI were noted. Subarachnoid block was given with injection Levobupivacaine 0.5% (heavy) 2.2ml at L2-L3/L3-L4 intervertebral space. Hypotension was calculated as a fall in mean arterial pressure which exceeded 25% of baseline measurement. The baseline PI and intraoperative vitals were assessed to evaluate the predictability of hypotension using baseline PI. **Result:** There was no notable correlation to link baseline PI and hypotension incidence. The area under the curve for usefulness of baseline perfusion index in forecasting hypotension was only 0.586 (p value = 0.118), which was not statistically significant. The cutoff of baseline PI 3.5 failed in predicting hypotension yielding sensitivity and specificity of 51.2% and 61% respectively. The study also revealed a new optimal cut-off of 1.85 which had a sensitivity of 72.1%, specificity of 46.8% and accuracy of only 55.8%. **Conclusion:** Perfusion index does not prove to be a useful instrument to predict an incidence of hypotension in healthy pregnant patients who undergo elective lower segment caesarean section under subarachnoid block with Levobupivacaine 0.5% (heavy).

KEYWORDS : hypotension, levobupivacaine 0.5% (heavy), perfusion index

INTRODUCTION

Spinal anaesthesia is the technique most frequently employed for anaesthesia during a caesarean section as it avoids any probable risks related to airway management in parturients (Arslan et al., 2019). Hypotension is common subsequent to spinal anaesthesia. Hypotension incidence following subarachnoid block for caesarean deliveries differs in various studies, ranging from 7.4% to 74.1% (Šklebar et al., 2019). Term pregnant women have lower mean arterial pressure, high sensitivity to local anaesthetics and are less reactive to vasopressors. As a result, severe hypotension can occur in pregnant patients consequent to spinal anaesthesia (Thapa et al., 2022).

Spinal anaesthesia for caesarean sections is more commonly performed using 0.5% hyperbaric Bupivacaine (Panda et al., 2023). The affinity of R and S enantiomers for various sodium and potassium ion channels differs. It is the reason for remarkable reduction in cardiac and central nervous system toxicity of S enantiomers in comparison to R enantiomers. Levobupivacaine being the pure S(-) enantiomer of Bupivacaine is less cardio and neurotoxic (Girish et al., 2018).

Pulse oximetry represents the amount of oxygenation in arterial blood. The perfusion index from pulse oximetry is a continuous, noninvasive way to measure peripheral perfusion (Ginosar et al., 2009). Photodetector assesses the light transmission for both pulsatile (AC) and non pulsatile (DC) components across two distinct wavelengths of 660nm and 940nm. The pulsatile components are derived from arterial blood while the non pulsatile component includes all other tissues such as venous blood. Given that the AC component represents only 1% to 2% of the overall signal, precision is highly essential. The Perfusion Index (PI) quantifies the ratio of pulsatile flow of blood to static or non pulsatile blood present in peripheral tissues (Thapa et al., 2022).

PI represents the quantitative measure of the intensity of plethysmographic pulse wave. When the pulsating signal is compared to the non-pulsating one, it is articulated as a ratio, typically identified as PI=AC/DC*100 (Mowafi et al., 2009). Thus, PI indicates peripheral vascular tone. A low PI signals peripheral vasoconstriction (or extreme hypovolemia) whereas high PI denotes vasodilation (Cannesson & Talke, 2009). An elevation in PI serves as an early indicator that peripheral vasodilation induced by both general and epidural anaesthetics, have set in ahead of the actual anaesthetic effect. Rise in PI is an indicator of successful onset of anaesthesia (Goldman et al., 2000).

In an earlier study conducted by Toyama et al. (2013), parturients with baseline PI >3.5 were found to be at more risk of developing hypotension following spinal injection. The present study was conducted with the primary objective of predicting hypotension in caesarean section under spinal anaesthesia with levobupivacaine 0.5% (heavy) using baseline perfusion index (PI). The secondary objectives included incidence of other side effects.

MATERIALS AND METHODS

This double-blind prospective observational study was conducted in Department of Anaesthesiology and Critical care, B.R.L.S.A.B.V.M. Medical College, Rajnandgaon, (CG) after obtaining sanction from the Institutional Ethics and Scientific Committee from April 2024 to July 2024. This observational study was registered with CTRI (CTRI/2024/04/064948). 120 term parturients posted for elective lower segment caesarean section in age group 18-40 years, ASA II, height 150-160cm were included in the study. Emergency cases, Antepartum haemorrhage, Postpartum haemorrhage, Patients with endocrine disease including GDM and thyroid disorders, Gestational hypertension/PIH/Preeclampsia, cardiovascular or cerebrovascular disease, morbid obesity (BMI>40kg/m^2), gestational age less than 37 or more than 40 weeks, patients who had contraindications to spinal anesthesia or foetus with known congenital anomalies were not included.

The sample size was calculated based on an earlier study (Toyama et al., 2013), using the formula, $N = [(Z\alpha+Z\beta) / C]^2 + 3$ where, $C=0.5*\ln[(1+r)(1-r)]$. The minimum sample size obtained was 39. But, in order to increase the reliability and power of study and to avoid data loss, 120 samples were taken. An informed written consent was taken from all the participants. Parturients were instructed to avoid solid foods for 8 hours and clear liquids for 2 hours. Standard monitoring equipments like Automated NIBP, pulse oximetry (SpO2) and electrocardiography were attached to the patient. PI was assessed using a specific pulse

oximeter probe (BPL multipara monitor) in the Left index finger of all expectants in supine position thereby ensuring uniformity. The baseline hemodynamic readings including PI were documented by an anaesthesiologist who did not participate in any subsequent monitoring of patient.

After ensuring intravenous access in left upper limb with an 18G peripheral venous catheter, patients were given injection pantoprazole 40mg iv and injection metoclopromide 10mg iv 1 hour before the surgery. Each patient was hydrated with 15ml/kg of Ringer Lactate over 30 minutes. Baseline measurements of heart rate (HR), diastolic blood pressure (DBP), systolic blood pressure (SBP), mean arterial pressure (MAP), SpO2 and baseline PI were documented in supine position after hydration. Under strict asepsis, subarachnoid block was performed in left lateral position in L3-L4 or L4-L5 intervertebral space with hyperbaric Levobupivacaine 0.5% 2.2ml at the rate of 0.2ml/sec after ensuring free flow of CSF. Then, parturients were laid supine with a left lateral inclination of 15 degrees. Loss of cold sensation with alcohol swabs was used to assess upper sensory block level. Maximum level of sensory blockade was checked 20 minutes after spinal anaesthesia. Parturients were excluded if the level of blockade was less than T6. HR, MAP, DBP, SBP, SpO2 and Perfusion Index were noted at 0, 1, 3, 5, 7, 10 minutes and every 5 minutes thereafter till conclusion of surgery.

Hypotension was interpreted as a fall in MAP of >25% from baseline. Hypotension was managed with 200ml of iv fluid bolus (Ringer Lactate). If it did not improve with fluids, injection Ephedrine 6mg iv bolus was given. Atropine 0.6mg iv injection was used to treat bradycardia (<55 beats/min). APGAR scores of newborns were noted at 1st and 5th minute of birth. Injection oxytocin was given 20 units in 500ml ringer lactate as 200mU/min infusion. Patients who needed supplementary uterotonic or other surgical procedures or who had lost more than 1000ml of blood were excluded. Side effects, if occurred were managed according to institutional protocol. The Chi-square test was utilized to examine the relationship between categorical variables. A p-value of less than 0.05 was established as the threshold for determining statistical significance in all analyses. The statistical evaluations were conducted using the SPSS statistical software, version 20.0.

RESULTS

A total of 120 patients were included in the study. None of them were excluded. Maximum number of parturients were in 21–25 years age range (i.e., 70 (58.3%) and minimum in ≤ 20 years (i.e., 5 (4.2%)). Mean age of parturients was (24.9 ± 3.2). The mean baseline PI was in the range of 3.32 ± 3. The minimum baseline PI was 0.16 and maximum was 11.5.

Incidence Of Hypotension

Out of the 120 patients, hypotension was noted in 43 (35.8%) patients and 77 (64.2%) patients did not have hypotension (Figure 1).

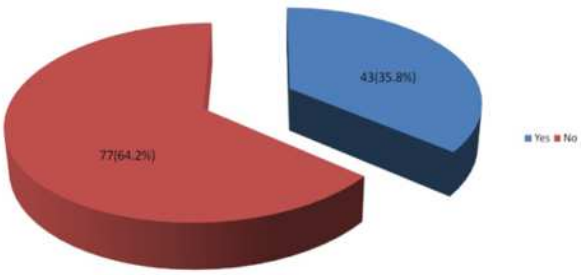


Figure 1: Percentage of the sample according to hypotension

Receiver Operating Characteristic (ROC) curve showing usefulness of perfusion index in predicting hypotension

The ROC curve of usefulness of perfusion index from pulse oximetry in prediction of hypotension in elective Caesarean sections following spinal anaesthesia was plotted (Figure 2). The area under the curve was 0.586 (p = 0.118), which was not significant. The sensitivity of this cutoff of 3.5 was 51.2% and specificity was 61%. The positive and negative predictive value were 42.3% and 69.1% respectively. The accuracy of the 3.5 cutoff was 57.5%. Based on the new optimal cutoff of 1.85 derived from the ROC curve, the sensitivity was 72.1% and specificity was 46.8%. The positive and negative predictive value were 43.1% and 75% respectively. The accuracy of the new cutoff was only 55.8%.

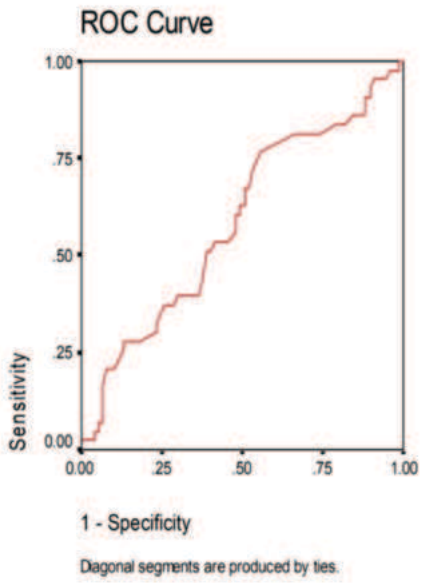


Figure 2: Receiver Operating Characteristic (ROC) curve showing usefulness of perfusion index in predicting hypotension Area under curve = 0.586 (0.479 – 0.694), p = 0.118 (not significant), p<0.05 was considered significant, p >0.05,not significant

Association of baseline abnormal HR with incidence of hypotension

Out of the 77 patients with normal heart rate, 25 patients (28.7%) had hypotension and 62 patients (71.3%) did not have hypotension (Table 1). Patients with a baseline heart rate exceeding 100 bpm experienced a higher incidence of hypotension, with a significant p value of 0.008.

Table 1: Association Of Baseline Abnormal HR With Incidence Of Hypotension

HR	Hypotension				χ^2	p
	Yes		No			
	Count	Percent	Count	Percent		
Abnormal	18	54.5	15	45.5	6.93	0.008
Normal	25	28.7	62	71.3		

HR - heart rate, χ^2 - chi-square value, Chi-square test was used to calculate the p value, The p value obtained was 0.008 (significant)

Haemodynamic Trends

The serial trend of heart rate (HR) and MAP were noted during the study. Immediately following spinal anaesthesia, the heart rate tend to fall till the 5th minute and later on, it showed a rising trend till around 20 minutes and then started falling back to baseline again (Figure 3).

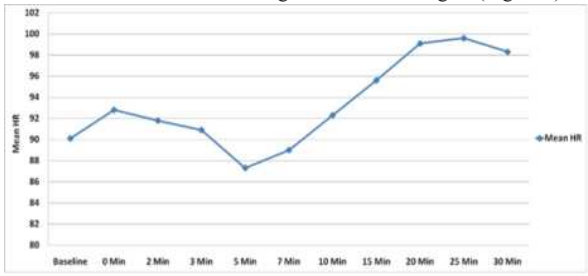
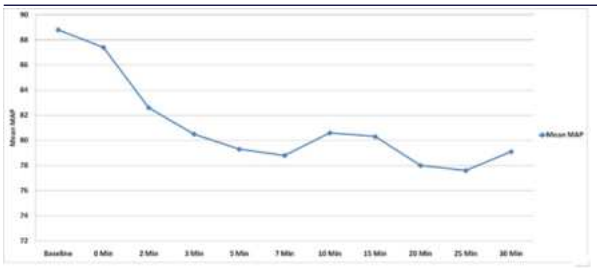


Figure 3: Trend of HR at various time intervals HR - heart rate

The MAP showed a serially falling trend till the 7th minute and then started rising. A second fall was noted around the 15th minute till the 25th minute (Figure 4).

Ephedrine Requirement

Out of the 43 patients who had hypotension, ephedrine was used in 15 patients (32.5%) only (Table 2). Others improved with fluid bolus alone.



MAP - Mean Arterial Pressure
Figure 4: Trend of MAP at various time intervals

Table 2: Percentage Of Sample According To Ephedrine Used

Ephedrine used	Count(N=43)	Percentage(%)
Yes	15	34.9
No	28	65.1

Adverse Effects

Nausea (12 patients, 10%), vomiting (4 patients, 3.33%) and shivering (8 patients, 6.67%) were the only other adverse effects which occurred during the study (Table 3).

Table 3: Adverse Effects

Adverse Effects	Count(N=120)	Percentage
Anaphylaxis	0	0
Bradycardia	0	0
Bradypnea	0	0
Nausea	12	10
Vomiting	4	3.33
Shivering	8	6.67
Arrhythmia	0	0
Neurological	0	0

DISCUSSION

The incidence of hypotension among the studied parturients was only 35.8%, which was less compared to other studies. Lee et al. (2017) and Klohr et al. (2010) reported that intraoperative hypotension is approximately 70 to 74% of CS. Attia et al. (2023) also had similar results, with incidence of hypotension 80% among the studied patients. This significant dissimilarity in incidence of hypotension may be attributed to the differences in definition of hypotension, hydration strategy and the local anaesthetic used.

In our study, the mean baseline PI varied between 0.16 and 11.5 with mean of 3.3 ± 2.3. Study by Toyama et al. (2013), had the baseline PI in parturients range from 0.7 to 8.6 with a mean value of 4.0.

Our study found that parturients with baseline heart rate greater than 100 bpm had a higher incidence of hypotension. According to Joshi et al. (2018), parturients with a greater baseline heart rate (HR > 90 bpm is used as the cutoff value) are more likely to experience hypotension during spinal anaesthesia. There was a statistically significant incidence of hypotension between the two groups (P is 0.260). Studies by Yokose et al. (2015) had comparable results whereas Singhal et al. (2023) had contrasting results (P value 0.31).

Immediately following spinal anaesthesia, the heart rate tend to fall till the 5th minute and later on, it showed a rising trend till around 20 minutes and then started falling back to baseline again. The initial fall in heart rate might be due to the sympathetic blockade caused by spinal anaesthesia. The compensatory response to hypotension and oxytocin administration following delivery of the baby could be causing a rise in heart rate after around 5 minutes. In the study by Attia et al. (2023), heart rate initially increased for the first 7 readings after spinal anesthesia compared to pre spinal anaesthesia.

In our study, the MAP showed a serially falling trend till the 7th minute and then started rising. It also showed a second fall in MAP around the 15th minute till the 25th minute. Similarly in the study by Attia et al. (2023), MAP decreased significantly all times after spinal anesthesia compared to pre spinal. Also, MAP showed decrease from first till fifth readings then started to increase again. Toyama et al. (2013) observed significant reductions in MAP following spinal injection in parturient women regardless of whether their baseline PI was high or low.

According to Duggappa et al. (2017) and Toyama et al. (2013), the perfusion index was utilized as an early indicator for hypotension following spinal anaesthesia. Their findings indicated that individuals who had a baseline PI greater than 3.5 experienced a higher rate of hypotension compared to those individuals whose PI was below 3.5. The sensitivity for the threshold of 3.5 in the study by Duggappa et al. (2017) was recorded at 69.84%, alongside a specificity of 89.29%.

Our study revealed results contrast to these. The area under the curve for usefulness of baseline perfusion index in predicting hypotension was only 0.586, with a p value of 0.118 which was not significant. The cutoff of baseline PI 3.5 failed in predicting hypotension with sensitivity of 51.2% and specificity of 61%. The study also revealed a new optimal cutoff of ≥1.85 which had a sensitivity 72.1% and specificity of 46.8%. But the accuracy was only 55.8%. Thus baseline perfusion index could not predict hypotension in parturients posted for elective LSCS. Comparable results were obtained in the study by Yokose et al. (2015), where the specificity and sensitivity (baseline PI cutoff of 3.5) of predicting hypotension was 42.86 and 47.83% respectively. Shah et al. (2021) also had parallel results.

There are various limitations to our study. Only those parturients in good health were selected for enrollment. The study did not include parturients suffering from hypertension and heart conditions, in whom predicting hypotension was essential. Serial trends in PI and its correlation with hypotension was not studied. The patient's movement and elevated sympathetic activity can swiftly alter PI results, even with our best efforts. In the absence of a medical indication for invasive arterial blood pressure monitoring, intermittent automated noninvasive blood pressure measurements were used.

CONCLUSION

Parturients exhibiting a baseline PI ≥3.5 did not experience an increased risk of hypotension compared to those with a PI lower than 3.5. Consequently, PI is not a predictive measure for hypotension in parturients who are scheduled to undergo elective LSCS with spinal anesthesia with Levobupivacaine 0.5% (heavy). Further studies with pulse oximeter probe on the lower limb might prove helpful. Serial trend in PI and its correlation with hypotension also need to be studied.

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