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Baseline Perfusion Index as a Predictor of Hypotension Following Subarachnoid Block in Parturients Undergoing Lower Segment Caesarean Section: A Prospective Observational Study

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Abstract

Background: Hypotension following spinal anesthesia for lower segment caesarean section (LSCS) is a common complication that may adversely affect maternal and fetal outcomes. Early identification of patients at risk can facilitate timely preventive measures. The perfusion index (PI), derived from pulse oximetry, reflects peripheral vascular tone and may serve as a non-invasive predictor of post-spinal hypotension. ***Methods:*** This prospective observational study was conducted among 100 parturients undergoing elective LSCS under subarachnoid block. Baseline perfusion index was measured prior to spinal anesthesia using a pulse oximeter probe. Participants were categorized into two groups based on baseline PI: Low PI (≤3.5) and High PI (>3.5). Hemodynamic parameters were monitored intraoperatively. Hypotension was defined as a decrease in systolic blood pressure to less than 80% of baseline or <90 mmHg. The incidence, severity, and timing of hypotension, along with vasopressor requirement, were recorded and analyzed. ***Results:*** The overall incidence of post-spinal hypotension was 40%. Hypotension occurred significantly more frequently in the high PI group compared with the low PI group (60% vs 20%, $p < 0.001$). The onset of hypotension was earlier in patients with PI >3.5 (3.85 ± 1.46 minutes) compared with those with PI ≤3.5 (8.28 ± 2.72 minutes). Patients in the high PI group also experienced a greater percentage fall in systolic blood pressure and required higher doses of vasopressors. Logistic regression analysis identified baseline PI as the only independent predictor of hypotension. ***Discussion:*** The findings suggest that baseline perfusion index reflects underlying vascular tone and autonomic balance, influencing the haemodynamic response to spinal anesthesia. Higher PI values are associated with increased risk and severity of hypotension, supporting its role as a useful screening parameter in obstetric anesthesia. ***Conclusion:*** Baseline perfusion index is a simple, non-invasive, and clinically useful predictor of hypotension following subarachnoid block in parturients undergoing LSCS. Incorporating PI into routine pre-anesthetic assessment may facilitate early risk stratification and proactive haemodynamic management.

Keywords: Perfusion index; Spinal anesthesia; Hypotension; Caesarean section; Obstetric anesthesia; Hemodynamic monitoring.

INTRODUCTION

Subarachnoid block (SAB), commonly known as spinal anesthesia, is the most widely preferred anesthetic technique for lower segment caesarean section (LSCS) due to its rapid onset, reliable sensory and motor blockade, simplicity, and minimal fetal drug exposure compared to general anesthesia. Despite these advantages, maternal hypotension remains one of the most common and clinically significant complications associated with SAB, posing risks to both the mother and the fetus [1].

The primary mechanism of hypotension following spinal anesthesia is sympathetic blockade. The administration of local anesthetic into the subarachnoid space results in inhibition of preganglionic sympathetic fibers, leading to vasodilation, decreased systemic vascular resistance, and venous pooling. This ultimately reduces venous return and cardiac output, causing a decline in arterial blood pressure. The clinical importance of this hypotension lies in its impact on uteroplacental perfusion, as reduced maternal blood pressure can compromise fetal oxygenation and lead to fetal hypoxia and acidosis. Therefore, early identification and prevention of hypotension are critical in obstetric anesthesia practice [2].

Physiological changes during pregnancy further increase the susceptibility of parturients to hemodynamic

instability. The gravid uterus compresses the inferior vena cava and aorta in the supine position, resulting in aortocaval compression and decreased venous return. Additionally, pregnancy is associated with increased blood volume, reduced systemic vascular resistance, and elevated cardiac output due to hormonal influences. Although these changes are adaptive, they make the maternal cardiovascular system more sensitive to sympathetic blockade, thereby increasing the likelihood of hypotension following spinal anesthesia [2,3].

Given the high incidence and potential complications of spinal anesthesia-induced hypotension, identifying reliable predictors is essential. Traditional predictors such as age, body mass index, and baseline blood pressure have shown limited predictive value due to significant interindividual variability. Hence, there is a need for objective, noninvasive, and easily measurable parameters that can accurately predict hypotension in clinical practice.

The perfusion index (PI) has emerged as a promising noninvasive parameter for this purpose. It is derived from pulse oximetry and represents the ratio of pulsatile to non-pulsatile blood flow in peripheral tissues. The PI reflects peripheral perfusion and is influenced by vascular tone, local temperature, and sympathetic nervous system activity. A higher PI indicates vasodilation and lower sympathetic tone, whereas a lower PI suggests vasoconstriction and higher sympathetic activity [4].

The association between baseline PI and post-spinal hypotension is based on autonomic physiology. Patients with higher baseline PI are likely to have reduced sympathetic tone and increased peripheral vasodilation. When spinal anesthesia induces further sympathetic blockade, these patients may experience a greater reduction in systemic vascular resistance and blood pressure. Conversely, individuals with lower baseline PI may have higher sympathetic tone, providing some degree of protection against severe hypotension. Thus, baseline PI can serve as a simple and noninvasive predictor of hemodynamic response following spinal anesthesia [5,6].

Various methods have been investigated to predict hypotension after spinal anesthesia, including heart rate variability, stroke volume variation, and pleth variability index. Although these methods offer valuable insights, they often require advanced monitoring equipment and are not feasible in all clinical settings. In contrast, the perfusion index is easily obtainable using standard pulse oximeters, does not require invasive procedures, and provides continuous real-time monitoring, making it highly suitable for routine clinical use, particularly in resource-limited settings [7,8].

From a physiological perspective, spinal anesthesia leads to redistribution of blood from the central circulation to the peripheral vascular compartments due to vasodilation. This results in decreased preload and afterload, leading to reduced cardiac output and arterial pressure. The severity of these changes depends on the extent of sympathetic blockade and the patient's baseline autonomic status. Since PI reflects peripheral vascular tone and sympathetic activity, it offers valuable insight into the patient's hemodynamic reserve and potential response to spinal anesthesia [10].

Several studies have demonstrated a significant association between higher baseline PI values and the occurrence of hypotension following spinal anesthesia in cesarean sections. Although the exact cutoff values vary across studies, the consistent finding is that patients with higher PI are more prone to significant decreases in blood pressure after SAB. This supports the role of PI as a useful screening tool in obstetric anesthesia [11].

In addition to its predictive value, the perfusion index can be monitored continuously during the perioperative period. Changes in PI can reflect alterations in vascular tone and response to interventions such as fluid therapy and vasopressor administration. Furthermore, PI may also be influenced by factors such as pain, anxiety, and temperature, providing additional information about the patient's physiological status [12].

Given its simplicity, noninvasive nature, and clinical applicability, the perfusion index holds significant potential as a predictor of hypotension in obstetric anesthesia. Early identification of high-risk patients can facilitate timely preventive measures, thereby improving maternal and fetal outcomes.

The present study was undertaken to evaluate the role of baseline perfusion index as a predictor of hypotension following subarachnoid block in patients undergoing lower segment caesarean section.

AIM & OBJECTIVES

To evaluate the role of baseline perfusion index (PI) as a predictor of hypotension following subarachnoid block in patients undergoing lower segment caesarean section (LSCS).

Objectives:

- To assess the baseline perfusion index (PI) in the upper limb of parturients undergoing LSCS.
- To determine the incidence of hypotension following subarachnoid block.
- To evaluate the association between baseline perfusion index and the occurrence of hypotension after spinal anesthesia.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Obstetrics and Gynaecology at S.C.B. Medical College and Hospital, Cuttack, Odisha, over a period of 18 months from February 2024 to June 2025. The study aimed to evaluate the relationship between baseline perfusion index (PI) and the incidence of hypotension following subarachnoid block in patients undergoing lower segment caesarean section (LSCS).

A total of 100 parturients scheduled for elective LSCS under spinal anesthesia were included using a convenience sampling method. Participants were selected based on predefined inclusion and exclusion criteria. Inclusion criteria comprised ASA physical status II, singleton full-term pregnancy (≥37 weeks), and willingness to participate. Patients with contraindications to spinal anesthesia, pre-existing hypertension, cardiovascular or systemic disorders, obesity (BMI >40 kg/m²), emergency LSCS, or conditions likely to cause hemodynamic instability were excluded.

After obtaining informed consent, standard monitoring including non-invasive blood pressure, ECG, and pulse oximetry was established. Baseline parameters such as heart rate, systolic and diastolic blood pressure, mean arterial pressure, oxygen saturation, and perfusion index were recorded with the patient in the supine position with left uterine displacement. The perfusion index was measured using a pulse oximeter probe attached to the left index finger.

Participants were divided into two groups based on baseline PI values: Group 1 (PI ≤3.5) and Group 2 (PI >3.5), with 50 patients in each group. Subarachnoid block was administered under aseptic precautions at the L3–L4 or L4–L5 interspace using a standard dose of hyperbaric bupivacaine. Hemodynamic parameters and PI were recorded at baseline, immediately after spinal anesthesia, at 1, 3, and 5 minutes, and then at 5-minute intervals until the end of surgery.

Hypotension was defined as a fall in systolic blood pressure to less than 80% of baseline or below 90 mmHg. The primary outcome was the incidence of hypotension, while secondary outcomes included severity, time of onset, number of episodes, vasopressor requirement, bradycardia, and associated symptoms such as nausea and vomiting.

Data were recorded in a structured proforma and analyzed using appropriate statistical methods. Categorical variables were expressed as percentages and compared using Chi-square or Fisher's exact test, while continuous variables were expressed as mean ± standard deviation and analyzed using t-test or Mann–Whitney U test. A p-value <0.05 was considered statistically significant.

Ethical approval was obtained from the Institutional Ethics Committee, and confidentiality of participants was maintained throughout the study.

RESULTS

A total of 100 parturients undergoing elective LSCS under spinal anesthesia were included in the study. The analysis focuses on baseline characteristics, perfusion index distribution, and its association with post-spinal hypotension.

Table 1: Distribution of Patients According to Age Group (n = 100)

Age group (years)	n	%
20–24	20	20.0
25–29	40	40.0
30–32	25	25.0
33–35	15	15.0
Total	**100**	**100.0**

The majority of participants belonged to the 25–29 years age group (40%), followed by 30–32 years (25%). This reflects a typical obstetric population in the reproductive age group.

Table 2: Distribution According to BMI Category (n = 100)

BMI category (kg/m²)	n	%
<25	26	26.0
25–29.9	42	42.0
30–34.9	24	24.0
≥35	8	8.0
Total	**100**	**100.0**

A large proportion (66%) of patients were overweight or obese, which may influence haemodynamic responses during spinal anesthesia.

Table 3: Baseline Perfusion Index and Group Distribution (n = 100)

Parameter	Low PI (≤3.5) (n=50)	High PI (>3.5) (n=50)	Total
Mean PI	2.72 ± 0.42	4.58 ± 0.76	3.65 ± 1.12
Range	2.00–3.50	3.60–6.20	2.00–6.20

Group	n	%
Low PI (≤3.5)	50	50.0
High PI (>3.5)	50	50.0
Total	**100**	**100.0**

Participants were equally distributed into low and high PI groups. The clear difference in mean PI confirms appropriate classification.

Table 4: Comparison of Baseline Haemodynamic Parameters Between PI Groups (n = 100)

Parameter	Low PI (Mean ± SD)	High PI (Mean ± SD)	p value
SBP (mmHg)	123.12 ± 11.06	124.35 ± 8.04	0.525
DBP (mmHg)	77.25 ± 6.38	77.76 ± 6.38	0.688
MAP (mmHg)	92.53 ± 6.07	93.29 ± 4.68	0.487
HR (beats/min)	88.18 ± 9.38	91.50 ± 9.62	0.084

Baseline haemodynamic parameters were comparable between groups ($p > 0.05$), indicating that differences in outcomes are likely attributable to PI rather than baseline instability.

Table 5: Incidence of Post-Spinal Hypotension According to PI Group (n = 100)

Hypotension	Low PI n (%)	High PI n (%)	Total n (%)
Absent	40 (80.0)	20 (40.0)	60 (60.0)
Present	10 (20.0)	30 (60.0)	40 (40.0)
Total	**50**	**50**	**100**

Chi-square = 16.67, $p < 0.001$

Hypotension occurred significantly more frequently in the High PI group (60%) compared to the Low PI group (20%), indicating a strong association between higher baseline PI and hypotension.

Table 6: Severity and Onset of Hypotension According to PI Group

(A) Severity of Hypotension

Severity	Low PI n (%)	High PI n (%)	Total
None	40 (80.0)	20 (40.0)	60
Mild	4 (8.0)	14 (28.0)	18
Moderate	5 (10.0)	11 (22.0)	16
Severe	1 (2.0)	5 (10.0)	6

$p = 0.001$

(B) Time to Onset (minutes, hypotensive patients only)

Group	Mean ± SD
Low PI	8.28 ± 2.72
High PI	3.85 ± 1.46

$p < 0.001$

Patients in the High PI group not only had a higher incidence of hypotension but also experienced earlier onset and greater severity, indicating poorer haemodynamic stability.

DISCUSSION

The present study was conducted to evaluate the role of baseline perfusion index (PI) as a predictor of hypotension following subarachnoid block in parturients undergoing lower segment caesarean section. The findings demonstrate that baseline PI is significantly associated with the incidence, severity, and timing of post-spinal hypotension, thereby supporting its utility as a simple and non-invasive predictive tool in obstetric anaesthesia.

In this study, the overall incidence of post-spinal hypotension was 40%, which is consistent with previous reports indicating a high and variable incidence of hypotension following spinal anaesthesia in caesarean delivery [20]. A key finding was the significantly higher

incidence of hypotension in the high PI group compared to the low PI group (60% vs 20%, $p < 0.001$). This threefold increase highlights the strong predictive value of baseline PI. Similar observations have been reported by Duggappa et al., who demonstrated a markedly higher incidence of hypotension in patients with PI >3.5 [6], and by Toyama et al., who identified baseline PI as a reliable predictor with good sensitivity and specificity [11]. These findings reinforce the concept that higher baseline PI reflects lower sympathetic tone and increased vasodilation, predisposing patients to exaggerated haemodynamic responses after spinal blockade.

The severity of hypotension was also significantly greater in the high PI group, with more patients experiencing moderate to severe hypotension compared to the low PI group. This aligns with previous studies indicating that PI is not only predictive of hypotension occurrence but also of its clinical severity. Lal et al. similarly reported a higher number of hypotensive episodes and greater haemodynamic instability in patients with higher PI values [21]. The present findings further support the physiological basis that reduced baseline vascular tone enhances the impact of sympathetic blockade, leading to more pronounced blood pressure reductions.

Another important observation was the significantly earlier onset of hypotension in the high PI group (3.85 vs 8.28 minutes, $p < 0.001$). Early onset hypotension is clinically relevant as it may occur before routine monitoring intervals, necessitating proactive management. Nandini et al. also reported that hypotension tends to occur earlier in patients with higher PI values, particularly within the first 10 minutes following spinal anaesthesia [22]. This emphasizes the importance of vigilant monitoring and early intervention in high-risk patients identified by elevated baseline PI.

The magnitude of systolic blood pressure fall was significantly greater in the high PI group, with a mean reduction of approximately 36% compared to 25% in the low PI group. This finding is consistent with Toyama et al., who reported a positive correlation between baseline PI and the degree of blood pressure reduction following spinal anaesthesia [11]. The observed correlation in the present study ($r = 0.344$, $p = 0.030$) further supports this association, indicating that higher PI is linked to more severe haemodynamic compromise.

Vasopressor requirement was universal among hypotensive patients; however, the total dose required was significantly higher in the high PI group. This finding is clinically important as it reflects increased haemodynamic instability and greater resource utilization. Duggappa et al. similarly demonstrated that higher baseline PI was associated with increased vasopressor requirement [6]. The ability of PI to predict not only the occurrence but also the treatment intensity of hypotension enhances its clinical relevance.

Baseline haemodynamic parameters such as systolic blood pressure, diastolic blood pressure, mean arterial pressure, and heart rate were comparable between the two groups, indicating that routine vital signs may not adequately predict hypotension risk. This finding supports previous studies which have shown that conventional parameters lack predictive accuracy due to interindividual variability [23]. In contrast, PI provides additional physiological insight into peripheral vascular tone, making it a more sensitive predictor.

Multivariable logistic regression analysis confirmed that PI group was the only independent predictor of hypotension, while BMI, baseline MAP, and gestational age were not significant. This is in agreement with prior studies suggesting that PI reflects functional vascular status rather than static demographic variables [24]. The ROC analysis in the present study demonstrated fair predictive ability (AUC = 0.739), which is comparable to previous studies reporting AUC values ranging from 0.80 to 0.91 [5,25]. Although variability exists in optimal cut-off values across studies, the threshold of approximately 3.5 used in this study remains clinically relevant and widely supported.

Maternal adverse effects such as nausea, vomiting, bradycardia, and shivering were more frequent in the high PI group, although not statistically significant. This trend is consistent with the higher incidence and severity of hypotension observed in this group. Previous studies have similarly linked hypotension with increased maternal discomfort and intraoperative symptoms [20].

Neonatal outcomes, including Apgar scores and NICU admission, were comparable between groups despite differences in maternal haemodynamics. This suggests that timely detection and management of hypotension can mitigate adverse fetal outcomes. Hung et al. also reported that early identification and management of hypotension are crucial in maintaining favorable neonatal outcomes [25].

Overall, the findings of this study highlight the clinical utility of baseline perfusion index as a predictor of post-spinal hypotension. Its non-invasive nature, ease of measurement, and ability to provide real-time physiological information make it a valuable addition to routine pre-anaesthetic assessment. Incorporating PI into clinical practice may facilitate early risk stratification, proactive haemodynamic management, and improved maternal safety.

CONCLUSION

The present study demonstrates that baseline perfusion index (PI) is a reliable, non-invasive, and independent predictor of hypotension following subarachnoid block

in parturients undergoing lower segment caesarean section. Despite comparable baseline characteristics and haemodynamic parameters, significant differences were observed in hypotension outcomes between PI groups. Patients with a baseline PI >3.5 had a markedly higher incidence of hypotension, approximately three times greater than those with lower PI values. Additionally, hypotension in the high PI group occurred earlier, was more severe, and required higher vasopressor doses, indicating greater haemodynamic instability.

Baseline PI remained the only independent predictor of hypotension after adjusting for other variables such as BMI, baseline mean arterial pressure, and gestational age. Receiver operating characteristic analysis further supported its predictive value, demonstrating acceptable sensitivity and specificity. The positive correlation between PI and the magnitude of systolic blood pressure fall reinforces its physiological relevance.

Although maternal adverse effects were more frequent in the high PI group, neonatal outcomes remained comparable, suggesting effective management of hypotension. Overall, baseline PI can serve as a practical tool for early risk stratification and proactive haemodynamic management in obstetric anaesthesia.

REFERENCES

1. Consensus Development Conference. Diagnosis, prophylaxis, and treatment of osteoporosis. Am J Med. 1993;94(6):646–50.
2. Bonjour JP, Theintz G, Buchs B, Slosman D, Rizzoli R. Critical years and stages of puberty for spinal and femoral bone mass accumulation. J Clin Endocrinol Metab. 1991;73(3):555–63.
3. Riggs BL, Melton LJ. Involutional osteoporosis. N Engl J Med. 1986;314(26):1676–86.
4. Compston JE, McClung MR, Leslie WD. Osteoporosis. Lancet. 2019;393(10169):364–76.
5. International Osteoporosis Foundation. The Asian Audit: Epidemiology, costs and burden of osteoporosis in Asia 2013. Nyon: IOF; 2013.
6. Malhotra N, Mithal A. Osteoporosis in Indians. Indian J Med Res. 2008;127(3):263–8.
7. Marwaha RK, Tandon N, Garg MK, Kanwar R, Narang A, Sastry A, et al. Bone health in healthy Indian population aged 50 years and above. Osteoporos Int. 2011;22(11):2829–36.
8. Khosla S, Amin S, Orwoll E. Osteoporosis in men. Endocr Rev. 2008;29(4):441–64.
9. Aggarwal N, Raveendran A, Khandelwal N, Sen RK, Thakur JS, Dhaliwal LK. Prevalence and related risk factors of osteoporosis in peri- and postmenopausal women. J Midlife Health. 2011;2(2):81–5.
10. Sharma S, Tandon VR, Mahajan A, Kour A. Menopause and osteoporosis: Indian scenario. J Midlife Health. 2016;7(2):75–9.
11. World Health Organization. Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. WHO Technical Report Series 843. Geneva: WHO; 1994.
12. Blake GM, Fogelman I. The role of DXA bone density scans in the diagnosis and treatment of osteoporosis. Postgrad Med J. 2007;83(982):509–17.
13. Kanis JA. Diagnosis of osteoporosis and assessment of fracture risk. Lancet. 2002;359(9321):1929–36.
14. Langton CM, Palmer SB, Porter RW. The measurement of broadband ultrasonic attenuation in cancellous bone. Eng Med. 1984;13(2):89–91.
15. Hans D, Dargent-Molina P, Schott AM, Sebert JL, Cormier C, Kotzki PO, et al. Ultrasonographic heel measurements to predict hip fracture in elderly women. Lancet. 1996;348(9026):511–4.
16. Nayak S, Olkin I, Liu H, Grabe M, Gould MK, Allen IE, et al. Meta-analysis: accuracy of quantitative ultrasound for identifying patients with osteoporosis. Ann Intern Med. 2006;144(11):832–41.
17. Krieg MA, Barkmann R, Gonnelli S, Stewart A, Bauer DC, Del Rio Barquero L, et al. Quantitative ultrasound in the management of osteoporosis: the 2007 ISCD official positions. J Clin Densitom. 2008;11(1):163–87.
18. Moayyeri A, Adams JE, Adler RA, Krieg MA, Hans D, Compston J, et al. Quantitative ultrasound of the heel and fracture risk assessment: an updated meta-analysis. Osteoporos Int. 2012;23(1):143–53.
19. Baim S, Leonard MB, Bianchi ML, Hans DB, Kalkwarf HJ, Langman CB, et al. Official positions of the ISCD for QUS in clinical practice. J Clin Densitom. 2008;11(1):16–27.
20. Lee A, Ngan Kee WD, Gin T. A quantitative systematic review of randomized controlled trials of ephedrine versus phenylephrine for the management of hypotension during spinal anesthesia for cesarean delivery. Anesth Analg. 2002;94(4):920–6.
21. Lal A, Goyal M, Singh M, et al. Perfusion index as a predictor of hypotension following spinal anesthesia in patients undergoing lower segment caesarean section. J Obstet Anaesth Crit Care. 2018;8(2):75–80.
22. Nandini M, Rajan S, Kumar L. Role of perfusion index in predicting hypotension after spinal anesthesia for caesarean section. Indian J Clin Anaesth. 2019;6(3):392–6.
23. Morgan GE, Mikhail MS, Murray MJ. Clinical Anesthesiology. 6th ed. New York: McGraw-Hill Education; 2018.
24. Butterworth JF, Mackey DC, Wasnick JD. Morgan & Mikhail's Clinical Anesthesiology. 6th ed. New York: McGraw-Hill; 2018.
25. Hung KC, Chen IW, Chang YJ, et al. Diagnostic accuracy of perfusion index for predicting hypotension after spinal anesthesia in parturients: A

systematic review and meta-analysis. J Clin Anesth. 2020;62:109732.