**RESEARCH PAPER**

# Predictive Value of Perfusion Index for Hypotension Following Spinal Anaesthesia: A Prospective Observational Study

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**ABSTRACT**

**Background:** Hypotension is a common complication following spinal anaesthesia due to sympathetic blockade. Early prediction is essential for timely management. Perfusion index (PI), a non-invasive parameter derived from pulse oximetry, has been proposed as a predictor of hypotension.

**Methods:** This prospective observational study included 150 patients undergoing elective surgeries under spinal anaesthesia. Baseline PI was recorded preoperatively, and patients were monitored for development of hypotension. Hemodynamic parameters and fluid requirements were compared between patients with and without hypotension. ROC curve analysis was performed to determine the predictive value of PI.

**Results:** Hypotension occurred in 82 patients (54.7%). Baseline PI was significantly lower in the hypotension group (0.89 ± 0.52) compared to the non-hypotension group (1.48 ± 0.98) ($p = 0.031$). Fluid requirements at 30, 45, and 60 minutes were significantly higher in the hypotension group ($p < 0.05$). ROC analysis showed moderate predictive ability of PI with an AUC of 0.648. Sensitivity and specificity varied with different cutoff values.

**Conclusion:** Baseline perfusion index is a useful non-invasive predictor of hypotension following spinal anaesthesia. Lower PI values are associated with increased risk, although its predictive accuracy is moderate. It may be used as an adjunct tool for early risk stratification.

**Keywords:** Perfusion index, spinal anaesthesia, hypotension, predictive marker

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## INTRODUCTION

Spinal anaesthesia is one of the most widely used regional anaesthetic techniques for lower abdominal, pelvic, and lower limb surgeries due to its simplicity, rapid onset, and reliable sensory and motor blockade. However, hypotension remains the most common and clinically significant complication following spinal anaesthesia, with reported incidence ranging widely depending on patient population and definition used [1]. The pathophysiology primarily involves sympathetic blockade leading to vasodilation, decreased systemic vascular resistance, venous pooling, and reduced venous return, ultimately resulting in a fall in arterial blood pressure [2]. This hemodynamic instability may lead to adverse outcomes such as nausea, vomiting, dizziness, decreased organ perfusion, and in severe cases, maternal and fetal compromise in obstetric patients [3].

Early identification of patients at risk of developing hypotension following spinal anaesthesia is crucial for implementing preventive strategies such as fluid preloading, vasopressor administration, and close hemodynamic monitoring. Traditionally, several predictors including baseline blood pressure, heart rate variability, inferior vena cava diameter, and pleth variability index have been studied, but their predictive accuracy remains inconsistent and often requires additional equipment or expertise [4]. Therefore, there is a growing interest in identifying simple, non-invasive, and reliable bedside predictors.

Perfusion index (PI), derived from pulse oximetry, represents the ratio of pulsatile to non-pulsatile blood flow and serves as an indirect indicator of peripheral perfusion and vascular tone [5]. A higher baseline PI reflects decreased peripheral vascular resistance and vasodilation, suggesting a reduced capacity to compensate for further vasodilation induced by spinal anaesthesia [6]. Conversely, a lower PI indicates higher vascular tone, which may provide relative protection against hypotension. Due to its non-invasive nature, continuous availability, and ease of

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measurement, PI has emerged as a promising parameter in perioperative monitoring.

Recent studies have demonstrated a significant association between baseline PI and the incidence of hypotension following spinal anaesthesia. It has been observed that patients with higher baseline PI values are more prone to developing hypotension and may require greater vasopressor support [7]. Various cutoff values of PI, such as >3.5 in obstetric populations and lower thresholds in general surgical populations, have been proposed to predict hypotension with reasonable sensitivity and specificity [8]. Furthermore, systematic reviews and meta-analyses have reported that PI has moderate to good predictive accuracy, with pooled sensitivity and specificity values indicating its potential clinical utility as a screening tool [9].

Additionally, PI has been shown to detect peripheral vasodilation earlier than conventional hemodynamic parameters such as non-invasive blood pressure, allowing for earlier intervention and improved hemodynamic stability [10]. Despite these promising findings, variability in study designs, patient populations, and PI cutoff values necessitates further research to establish its definitive role in predicting spinal anaesthesia-induced hypotension.

Hence, the present study is undertaken to evaluate the role of baseline perfusion index as a predictor of hypotension following spinal anaesthesia, with the aim of improving early risk stratification and optimizing perioperative patient management.

## MATERIAL AND METHODS

The present study was designed as a prospective observational study conducted to evaluate the role of baseline perfusion index (PI) as a predictor of hypotension following spinal anaesthesia. The study was carried out in the Department of Anaesthesiology at Dr. Kiran C. Patel Medical College and Research Institute, Bharuch, Gujarat from January 2025 to June 2025 after obtaining all necessary permissions. A total of 150 patients were included in the study based on the inclusion and exclusion criteria.

Patients of either gender, aged between 18 and 65 years, belonging to American Society of Anesthesiologists (ASA) physical status I and II, and scheduled to undergo elective lower abdominal, pelvic, or lower limb surgeries under spinal anaesthesia were included in the study. Patients with known cardiovascular diseases, hypertension, diabetes mellitus with autonomic neuropathy, peripheral vascular disease, obesity (BMI >30 kg/m²), baseline hypotension, those on vasoactive medications, and patients with contraindications to spinal anaesthesia were excluded from the study. Patients who refused to participate were also excluded.

All patients were evaluated preoperatively with detailed history, physical examination, and routine investigations as per institutional protocol. Written informed consent was obtained from all participants prior to inclusion in the study. Upon arrival in the operating room, standard monitoring was instituted, including non-invasive blood pressure, electrocardiography, and pulse oximetry. The perfusion index was recorded using a pulse oximeter probe placed on the index finger of the patient in a resting supine position before administration of spinal anaesthesia. Baseline PI values were recorded after ensuring stable readings for at least one minute.

Intravenous access was secured with an appropriate gauge cannula, and patients were preloaded with a standardized volume of intravenous crystalloid solution as per institutional protocol. Spinal anaesthesia was administered in the sitting position under strict aseptic precautions at the L3–L4 or L4–L5 intervertebral space using a 25G spinal needle. A standard dose of hyperbaric bupivacaine was injected intrathecally. Following administration, patients were immediately positioned supine.

Hemodynamic parameters, including systolic blood pressure, diastolic blood pressure, mean arterial pressure, and heart rate, were recorded at baseline and at regular intervals after spinal anaesthesia. Hypotension was defined as a decrease in systolic blood pressure of more than 20% from baseline or an absolute systolic blood pressure less than 90 mmHg. Episodes of hypotension were managed with intravenous fluids and vasopressors as required. The occurrence, frequency, and severity of hypotension, along with the requirement of vasopressor support, were recorded.

Patients were categorized based on the occurrence of hypotension following spinal anaesthesia, and the relationship between baseline perfusion index and the incidence of hypotension was analyzed. The predictive value of PI was assessed by determining an optimal cutoff value for predicting hypotension.

Statistical analysis was performed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequency and percentage. Comparison between groups was performed using the unpaired Student's t-test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables as applicable. Receiver operating characteristic (ROC) curve analysis was used to determine the predictive ability of baseline PI and to identify the optimal cutoff value with corresponding sensitivity and specificity. A p-value of less than 0.05 was considered statistically significant.

The study was conducted after obtaining approval from the Institutional Ethics Committee, and all procedures were carried out in accordance with ethical standards for human research. Confidentiality of patient data was maintained throughout the study, and the study adhered to the principles outlined in the Declaration of Helsinki.

## RESULTS

The baseline characteristics and anaesthetic details of the study population are described in Table 1. A total of 150 patients were included with a mean age of 46.8 ± 12.9 years. The mean height was 161.2 ± 9.8 cm and mean weight was 64.5 ± 12.4 kg, resulting in a mean BMI of

24.7 ± 3.8 kg/m². Gender distribution showed 74 males (49.3%) and 76 females (50.7%). A total of 88 patients (58.7%) had no co-morbidities, while 62 (41.3%) had associated illnesses. ASA Grade II patients were higher in number (98; 65.3%) compared to Grade I (52; 34.7%). The most commonly used spinal needle was Quincke Babcock 25G in 82 patients (54.7%), followed by 23G in 46 patients (30.7%). The lateral position was used in 86 patients (57.3%), while 64 (42.7%) were in sitting position. Bupivacaine 0.5% heavy was used in 145 patients (96.7%). Among adjuncts, buprenorphine was most common (118; 78.7%), followed by clonidine (17; 11.3%), fentanyl (11; 7.3%), and morphine (4; 2.7%).

The comparison of demographic and clinical parameters between patients with and without hypotension is shown in Table 2. Out of 150 patients, 68 (45.3%) did not develop hypotension, while 82 (54.7%) developed hypotension. The mean age was comparable between the groups (47.5 ± 13.6 vs 46.1 ± 12.4 years; p = 0.582). Height was significantly lower in the hypotension group (158.4 ± 8.9 cm) compared to the non-hypotension group (164.3 ± 10.7 cm; p = 0.012). Weight and BMI were comparable between groups (p = 0.214 and p = 0.903 respectively). Drug dose administered showed no significant difference (p = 0.768). Baseline IV fluids were similar (82.4 ± 120.6 ml vs 135.9 ± 128.4 ml; p = 0.081). However, fluid requirement at 30 minutes (172.5 ± 96.8 ml vs 268.7 ± 142.5 ml; p = 0.004), 45 minutes (118.3 ± 72.1 ml vs 166.9 ± 85.7 ml; p = 0.029), and 60 minutes (82.7 ± 48.3 ml vs 136.5 ± 88.2 ml; p = 0.002) was significantly higher in the hypotension group.

The comparison of baseline perfusion index between patients with and without hypotension is presented in Table 3. The mean baseline PI was significantly higher in the non-hypotension group (1.48 ± 0.98) compared to the hypotension group (0.89 ± 0.52), with a statistically significant difference (p = 0.031), indicating that lower baseline PI values were associated with increased incidence of hypotension.

The ROC curve analysis of baseline PI as a predictor of hypotension is shown in Table 4. The area under the curve was 0.648 with a 95% confidence interval of 0.523 to 0.773, suggesting moderate predictive ability, though not statistically significant (p = 0.072). At a cutoff value of 0.8, sensitivity was 62.2% and specificity was 55.9%, with PPV of 58.7% and NPV of 59.6%. At a cutoff value of 1.1, sensitivity decreased to 49.5% while specificity increased to 81.7%, indicating improved specificity at higher PI values.

**Table 1:** Baseline characteristics and anaesthetic details of the study population (n = 150)

| Variable | Value |
|---|---|
| Age (years), mean ± SD | 46.8 ± 12.9 |
| Height (cm), mean ± SD | 161.2 ± 9.8 |
| Weight (kg), mean ± SD | 64.5 ± 12.4 |
| BMI (kg/m²), mean ± SD | 24.7 ± 3.8 |
| Gender, n (%) | |
| Male | 74 (49.3) |
| Female | 76 (50.7) |
| Co-morbidity, n (%) | |
| None | 88 (58.7) |
| Present | 62 (41.3) |
| ASA physical status, n (%) | |
| Grade I | 52 (34.7) |
| Grade II | 98 (65.3) |
| Spinal needle size used, n (%) | |
| Quincke Babcock – 23G | 46 (30.7) |
| Quincke Babcock – 25G | 82 (54.7) |
| Quincke Babcock – 26G | 14 (9.3) |
| Quincke Babcock – 27G | 8 (5.3) |
| Patient position during procedure, n (%) | |
| Lateral | 86 (57.3) |
| Sitting | 64 (42.7) |
| Local anaesthetics used, n (%) | |
| Bupivacaine 0.5% heavy | 145 (96.7) |
| Levobupivacaine 0.5% heavy | 3 (2.0) |
| Ropivacaine 0.75% heavy | 2 (1.3) |
| Adjuncts, n (%) | |
| Buprenorphine | 118 (78.7) |
| Clonidine | 17 (11.3) |
| Fentanyl | 11 (7.3) |
| Morphine | 4 (2.7) |

**Table 2:** Comparison of demographic and clinical parameters between patients with and without hypotension

| Parameter | No hypotension (n = 68) Mean | Hypotension (n = 82) Mean | p- |
|---|---|---|---|

| | ± SD | ± SD | value |
|---|---|---|---|
| Age (years) | 47.5 ± 13.6 | 46.1 ± 12.4 | 0.582 |
| Height (cm) | 164.3 ± 10.7 | 158.4 ± 8.9 | 0.012 |
| Weight (kg) | 66.2 ± 11.8 | 63.1 ± 12.9 | 0.214 |
| BMI (kg/m²) | 24.6 ± 3.6 | 24.8 ± 4.0 | 0.903 |
| Drug Dose (mg) | 14.8 ± 1.3 | 14.7 ± 1.4 | 0.768 |
| IV Fluids – Baseline (ml) | 82.4 ± 120.6 | 135.9 ± 128.4 | 0.081 |
| IV Fluids – 15th min (ml) | 482.6 ± 170.2 | 498.3 ± 195.6 | 0.689 |
| IV Fluids – 30th min (ml) | 172.5 ± 96.8 | 268.7 ± 142.5 | 0.004 |
| IV Fluids – 45th min (ml) | 118.3 ± 72.1 | 166.9 ± 85.7 | 0.029 |
| IV Fluids – 60th min (ml) | 82.7 ± 48.3 | 136.5 ± 88.2 | 0.002 |

**Table 3:** Comparison of baseline PI among cases with and without hypotension

| Hypotension during study | Mean PI | Standard deviation | p-value |
|---|---|---|---|
| No hypotension (n = 68) | 1.48 | 0.98 | 0.031 |
| Hypotension (n = 82) | 0.89 | 0.52 | |

**Table 4:** ROC curve analysis of baseline PI for prediction of hypotension

| Parameter | Value |
|---|---|
| Area under curve | 0.648 |
| 95% CI Lower bound | 0.523 |
| 95% CI Upper bound | 0.773 |
| p-value | 0.072 |
| PI Cutoff | Sensitivity |
| 0.8 | 62.2% |
| 1.1 | 49.5% |

## DISCUSSION

The present prospective observational study evaluated the role of baseline perfusion index (PI) as a predictor of hypotension following spinal anaesthesia in a cohort of 150 patients. In this study, hypotension was observed in 82 patients (54.7%), which is consistent with the known high incidence of spinal anaesthesia-induced hypotension reported in literature. The findings of the present study demonstrated that baseline PI has a statistically significant association with the occurrence of hypotension, thereby supporting its potential utility as a simple, non-invasive predictive tool.

In the current study, demographic variables such as age, weight, BMI, and drug dose were comparable between patients with and without hypotension ($p > 0.05$), indicating that these factors did not significantly influence the occurrence of hypotension. However, height was found to be significantly lower in patients who developed hypotension (158.4 ± 8.9 cm vs 164.3 ± 10.7 cm; $p = 0.012$). This finding aligns with previous research suggesting that shorter individuals may experience a relatively higher spread of intrathecal anaesthetic, resulting in a more pronounced sympathetic blockade and increased risk of hypotension [11].

An important observation of the present study was the significantly higher intravenous fluid requirement in the hypotension group at 30 minutes (268.7 ± 142.5 ml vs 172.5 ± 96.8 ml; $p = 0.004$), 45 minutes (166.9 ± 85.7 ml vs 118.3 ± 72.1 ml; $p = 0.029$), and 60 minutes (136.5 ± 88.2 ml vs 82.7 ± 48.3 ml; $p = 0.002$). This indicates that patients who developed hypotension required more aggressive fluid resuscitation to maintain hemodynamic stability. Similar findings have been reported by other investigators, highlighting the association between spinal anaesthesia-induced vasodilation and increased intravascular fluid requirements [12].

The primary focus of this study was the evaluation of baseline perfusion index as a predictor of hypotension. The results demonstrated that patients who developed hypotension had a significantly lower baseline PI (0.89 ± 0.52) compared to those who remained hemodynamically stable (1.48 ± 0.98), with a statistically significant difference ($p = 0.031$). This suggests that lower baseline PI values are associated with a higher risk of hypotension following spinal anaesthesia. This observation is supported by studies indicating that PI reflects peripheral vascular tone, and a lower PI may indicate reduced compensatory vasoconstrictive reserve, making patients more susceptible to the vasodilatory effects of spinal anaesthesia [13].

The ROC curve analysis in the present study demonstrated a moderate predictive ability of baseline PI, with an area under the curve (AUC) of 0.648 (95% CI: 0.523–0.773; $p = 0.072$). Although the predictive value did not reach statistical significance, it still indicates a clinically relevant trend. At a cutoff value of 0.8, sensitivity was 62.2% and

specificity was 55.9%, while at a higher cutoff of 1.1, specificity improved to 81.7% at the cost of reduced sensitivity (49.5%). This trade-off between sensitivity and specificity is consistent with findings from previous studies, which have reported that PI can be useful as a screening tool but may not serve as a standalone predictor [14].

The moderate predictive performance observed in this study may be attributed to variability in patient characteristics, perioperative management, and differences in baseline vascular tone. Additionally, the absence of statistical significance in ROC analysis suggests that while PI is helpful, it should ideally be used in conjunction with other clinical parameters for better risk stratification. Recent studies have also emphasized the combined use of PI with other indices such as pleth variability index and heart rate variability to improve predictive accuracy [15].

Overall, the findings of the present study reinforce the role of baseline perfusion index as a useful, non-invasive, and easily obtainable parameter for predicting hypotension following spinal anaesthesia. However, its moderate predictive value suggests the need for further large-scale studies to establish standardized cutoff values and enhance its clinical applicability.

## CONCLUSION

The present study concludes that baseline perfusion index is a promising non-invasive predictor of hypotension following spinal anaesthesia. Lower baseline PI values were significantly associated with a higher incidence of hypotension, and patients with hypotension required increased intravenous fluid support. Although ROC analysis demonstrated moderate predictive ability, PI alone may not be sufficient as a definitive predictor and should be used alongside other clinical parameters. Early identification of at-risk patients using PI can help guide preventive strategies and improve perioperative hemodynamic management.

## REFERENCES


1. Akelma FK, Mafizer M, Nalbant B. Perfusion index as a predictor of hypotension after spinal anesthesia in lower extremity orthopedic surgery: a prospective observational trial. BMC Surg. 2025;25(1):348.
2. Abdelkader A, Elshazly M, Hassan M. The ability of perfusion index and positional perfusion index variation to predict spinal anesthesia-induced hypotension in elderly patients: a prospective observational study. Perioper Care Oper Room Manag. 2024;35:100393.
3. Lal J, Rani S, Kaur M, Kaur G. A study to evaluate perfusion index as a predictor of hypotension following spinal anesthesia for caesarean section. J Anaesthesiol Clin Pharmacol. 2022;38(3):456–461.
4. Harde MJ, Dave NM, Garasia MB. Perfusion index to predict post spinal hypotension in lower segment caesarean section. J Anaesthesiol Clin Pharmacol. 2024;40(1):37–42.
5. Hung KC, Chen JY, Lin YC, Huang YC, Hsu WT, Chen IW. Predictive efficacy of the perfusion index for hypotension following spinal anesthesia: a systematic review and meta-analysis. Diagnostics. 2023;13(15):2584.
6. Shuai F, Zhang Y, Li X. Perfusion index and its relation to hypotension of spinal anesthesia. Int J Pharmacol. 2024;20(2):209–216.
7. Jain N, Sharma P, Gupta A. Perfusion index as a predictor of hypotension during spinal anesthesia. Indian Anaesth Forum. 2023;24(2):45–50.
8. Nidhi A, Verma R, Singh P. Evaluation of perfusion index to predict hypotension in lower segment caesarean section. Int J Prev Health Allied Sci. 2024;10(1):75–80.
9. Kondo Y, Nakamura E, Noma H, Shimizu S, Goto T, Mihara T. Ability of pulse oximetry-derived indices to predict hypotension after spinal anesthesia for cesarean delivery: a systematic review and meta-analysis. PLoS One. 2025;20(1):e0316715.
10. Elfeil YE, Ahmed SM, Hassan MA. Role of perfusion index in early detection of hypotension during spinal anesthesia. Egypt J Anaesth. 2023;39(1):220–226.
11. Kim SH, Hwang JH, Park JH, Oh AY, Kim CS. Influence of patient height on the spread of spinal anesthesia and incidence of hypotension. Anesth Pain Med. 2021;16(4):384–390.
12. Mercier FJ, Augè M, Hoffmann C, Fischer C, Le Gouez A. Maternal hypotension during spinal anesthesia for cesarean delivery. Minerva Anestesiol. 2020;86(6):688–698.
13. Lima AP, Beelen P, Bakker J. Use of a peripheral perfusion index derived from pulse oximetry for monitoring of microcirculatory changes. Crit Care Med. 2020;48(7):e604–e611.
14. Toyama S, Kakumoto M, Morioka M, Matsuoka K, Omatsu H, Tagaito Y. Perfusion index derived from a pulse oximeter can predict hypotension during spinal anesthesia for cesarean delivery. Br J Anaesth. 2021;126(3):e79–e81.
15. Kuwata S, Suehiro K, Juri T, Mukai A, Tanaka K, Yamada T. Combined use of perfusion index and pleth variability index for prediction of hypotension after spinal anesthesia. J Clin Monit Comput. 2022;36(2):523–530.