Research Square

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Perfusion Index Measurement Can not Predict Hypotension During Procedural Sedation in Hypertensive Patients Undergoing Colonoscopy

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Research Article

Keywords: chronic hypertension, hypotension, photoplethysmography, procedural sedation, pulse oximetry

Posted Date: April 8th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9237273/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

Hypotension is frequently encountered during colonoscopy performed under propofol sedation. Patients with chronic hypertension often exhibit baroreceptor desensitisation, reduced vascular compliance, or intravascular volume depletion due to diuretic therapy. The perfusion index (PI), derived from photoplethysmographic signals, reflects beat-to-beat changes in blood volume. This study aimed to evaluate whether perioperative PI measurements can predict propofol-related hypotension during procedural sedation in patients with chronic hypertension.

Methods

This prospective study included 125 patients with chronic hypertension scheduled to undergo colonoscopy under propofol sedation. Perfusion index and blood pressure measurements were recorded preoperatively, at 3-minute intervals during the first 10 minutes following induction, and subsequently at 5-minute intervals. The association between PI values and the development of hypotension was analysed.

Results

Hypotension occurred in 28 patients (22.7%). Preoperative PI values did not differ significantly between patients who developed hypotension and those who did not ($p = 0.417$). Similarly, no significant association was found between hypotension and the PI-measurement/PI-baseline ratio ($p > 0.05$).

Conclusion

In this cohort of hypertensive patients undergoing procedural sedation with propofol, finger-derived perfusion index values were not effective in predicting the development of hypotension.

Introduction

Hypotension is a common occurrence during colonoscopy performed under propofol sedation (1). Patients with chronic hypertension frequently demonstrate impaired baroreceptor sensitivity, decreased vascular elasticity, and intravascular volume depletion related to chronic diuretic use(2). Bowel preparation and propofol sedation have also been identified as contributing factors to intra-procedural hypotension(3, 4).

Continuous non-invasive blood pressure monitoring during anaesthesia is essential for maintaining adequate organ perfusion and reducing perioperative and postoperative morbidity, including myocardial infarction, acute kidney injury, and cerebrovascular events.

The perfusion index (PI), calculated from photoplethysmographic (PPG) waveforms, represents the ratio of pulsatile to non-pulsatile signal components. The PPG waveform reflects beat-to-beat changes in blood volume via fluctuations in light absorption(5, 6). Previous studies have suggested that PI may help predict hypotension following induction of general anaesthesia with propofol(7).

The aim of this study was to determine whether PI could predict propofol-induced hypotension during procedural sedation in patients with chronic hypertension.

Methods

This study was conducted following approval from the Clinical Research Ethics Committee (University of Health Sciences, Hamidiye Faculty of Medicine, Istanbul, Turkey Approval No:23–79, Date: 21 December 2023).

Between January and March 2024, patients aged 30–80 years, classified as American Society of Anesthesiologists (ASA) physical status II–III, diagnosed with chronic hypertension, and scheduled for colonoscopy under propofol-based procedural sedation were enrolled. Patients were excluded if they had known hypersensitivity to study medications, advanced heart failure (New York Heart Association [NYHA] class II or higher), cardiac arrhythmias, peripheral arterial disease, malnutrition, or if they required emergency endoscopy or colonoscopy. Among 125 eligible patients, two were excluded because of endoscopy-related complications, leaving 123 patients for the final analysis.

Written informed consent was obtained from all participants.

Study protocol

Upon arrival in the endoscopy unit, demographic data (age, body weight, ASA classification, comorbidities, and number of antihypertensive medications) were recorded. An intravenous line was placed in the right arm, and patients were positioned in the left lateral decubitus position. Preoperative vital signs—non-invasive arterial blood pressure, heart rate, and oxygen saturation—were obtained. In the same position, the preoperative perfusion index (PI) was measured from the fourth finger of the right hand, maintained at heart level. To ensure reliability, PI measurements were repeated three times at 30-second intervals, and the mean value was used.

Premedication routinely administered in our clinic—midazolam (0.02–0.03 mg·kg⁻¹) and fentanyl (0.5 µg·kg⁻¹)—was given to all patients. Procedural sedation was initiated with propofol 1 mg·kg⁻¹ according to the institutional protocol.

Following induction, non-invasive blood pressure, heart rate, oxygen saturation, and PI were recorded every 3 minutes during the first 10 minutes and subsequently at 5-minute intervals. Hypotension was defined as a mean arterial pressure < 65 mmHg or a $> 30\%$ decrease from baseline systolic blood pressure. Hypotension was initially treated with 4 mL·kg⁻¹ intravenous crystalloid; if unresponsive, 5 mg intravenous ephedrine boluses were administered at the discretion of the attending clinician.

The duration of the procedure and total propofol dose were recorded. At the end of the procedure, patients were transferred to the post-anaesthesia recovery unit and discharged once they achieved a Modified Aldrete score of 10, were able to ambulate independently, and exhibited no nausea or vomiting.

Statistical analysis

Based on the study by Min et al. (“Perfusion Index from the Ear as a Predictor of Hypotension Following Anaesthesia Induction in Hypertensive Patients”), a sample size of 120 patients was calculated using a 0.95 confidence interval, statistical power of 0.90, and an anticipated dropout rate of 20%.

Normality of distribution was assessed using the Shapiro–Wilk test. Continuous variables were summarised as mean ± standard deviation (SD) for normally distributed data and median (minimum–maximum) for non-normally distributed data. Categorical variables were expressed as frequency and percentage [n (%)].

Comparisons between independent groups were performed using the Mann–Whitney U test for non-normally distributed continuous variables. Categorical variables were analysed using the chi-square test with Yates correction or Fisher’s exact test, as appropriate.

All statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp., Armonk, NY, USA). A two-tailed p value < 0.05 was considered statistically significant.

Result

A total of 125 patients were enrolled in the study. Two patients were excluded due to complications related to the endoscopic procedure, and statistical analyses were performed on data from 123 patients. The demographic characteristics of the study

population are presented in Table 1. Of the patients, 52.1% were female and 47.9% were male, with a mean age of 63.09 ± 9.73 years.

Table 1
Demographic characteristics of the patients.

Variable	n (%) / Mean ± SD
Sex	
Female	64 (52.1%)
Male	59 (47.9%)
Age (years)	63.09 ± 9.73
Body Mass Index (kg m^{-2})	28.76 ± 4.94
Height (m)	1.65 ± 0.09
Weight (kg)	78.37 ± 14.34
ASA physical status	
II	101 (82.2%)
III	22 (17.8%)

Values of age, height, weight, and body mass index are presented as mean ± standard deviation. Sex and ASA classification are expressed as number (percentage).

The mean procedure duration, total propofol dose, and preoperative blood pressure values are shown in Table 2.

Table 2
Intraoperative variables.

Variable	Mean ± SD	Median (min–max)
Procedure duration (min)	16.28 ± 6.89	16 (6–30)
Propofol dose (mg)	153.57 ± 59.53	150 (40–420)
Preoperative systolic BP (mmHg)	139.24 ± 21.78	140 (91–188)
Preoperative diastolic BP (mmHg)	77.60 ± 11.19	79 (40–100)
Preoperative mean BP (mmHg)	98.15 ± 13.23	98.33 (65–126.67)

Intra-procedural hypotension occurred in 28 patients (22.8%). When preoperative perfusion index (PI□) values were compared between patients with and without

hypotension, no statistically significant difference was found ($p > 0.05$). The receiver operating characteristic (ROC) analysis of PI values is shown in Table 3.

According to ROC analyses of PI measurements at different time points (PI–PI/PI), no statistically significant differences were observed between the groups ($p > 0.05$) (Table 3).

Table 3
ROC analysis of preoperative PI (PI) and PI (each measurement)/PI values in patients who developed hypotension.

Risk factor	AUC (95% CI)	Cut-off	*p*	Sensitivity (%)	Specificity (%)
PI	0.551 (0.436–0.665)	3.35	0.417	82	60
PI/PI	0.547 (0.422–0.671)	2.45	0.455	28.6	11.6
PI/PI	0.518 (0.389–0.647)	1.64	0.770	39.3	23.2
PI/PI	0.519 (0.399–0.639)	1.07	0.761	32.1	23.2
PI/PI	0.569 (0.443–0.695)	0.71	0.267	35.7	15.8
PI/PI	0.560 (0.433–0.687)	1.33	0.338	17.9	4.2
PI/PI	0.569 (0.441–0.698)	0.13	0.266	17.9	4.2

Notes: PI = preoperative perfusion index; PI–PI = sequential intraoperative measurements; AUC = area under the curve.

There were no statistically significant associations between the presence of hypotension and categorical variables including sex, ASA classification, diabetes mellitus, or number of antihypertensive agents used ($p > 0.05$) (Table 4).

Table 4
Association between categorical variables and the occurrence of hypotension.

Variable	Hypotension present n (%)	Hypotension absent n (%)	*P*
Sex			0.080
Female	10 (35.7%)	54 (56.8%)	
Male	18 (64.3%)	41 (43.2%)	
ASA physical status			0.783
II	22 (78.6%)	79 (83.2%)	
III	6 (21.4%)	16 (16.8%)	
Diabetes mellitus			0.909
Present	11 (39.3%)	34 (35.8%)	
Absent	17 (60.7%)	61 (64.2%)	
Number of antihypertensive agents			0.926
1	10 (35.7%)	36 (37.9%)	
2	15 (53.6%)	51 (53.7%)	
3	3 (10.7%)	8 (8.4%)	
Chi-square test, $p < 0.05$			

A statistically significant difference was found between hypotension and age ($p < 0.05$), indicating that the risk of hypotension increased with advancing age (Table 5). No significant association was found between hypotension and body mass index (BMI) ($p > 0.05$).

Table 5
Comparison of age and BMI according to the occurrence of hypotension.

Variable	Hypotension	n	Mean ± SD	Median (min–max)	*p*
Age (years)	Present	28	66.89 ± 9.69	67 (47–83)	0.032*
	Absent	95	61.97 ± 9.50	63 (34–87)	
BMI (kg/m²)	Present	28	27.93 ± 5.84	26.94 (20.76–47.63)	0.097
	Absent	95	29.01 ± 4.66	28.13 (18.37–41.02)	
Mann–Whitney U test, $p < 0.05$					

Discussion

This study was designed to evaluate whether the perfusion index (PI) could serve as a useful predictor of hypotension during propofol-based procedural sedation in patients with chronic hypertension. When preoperative and intraoperative PI values were compared between patients who did and did not develop hypotension, no statistically significant differences were identified. However, increasing age was associated with a higher risk of hypotension.

Compared with general anesthesia, blood pressure monitoring during procedural sedation is performed at wider intervals, and the optimal measurement frequency has not yet been well established(8). The incidence of hypotension during procedural sedation has been reported as approximately 35%. Patients with hypertension have been shown to experience hypotension more frequently during anesthesia(9). Therefore, alternative non-invasive, dynamic monitoring tools that can assess blood pressure changes in this population remain desirable, and PI has been suggested as a potentially useful parameter(7, 10, 11).

Previous studies investigating PI have produced inconsistent findings. Mehandale et al. reported that lower baseline PI values were associated with a $\geq 30\%$ reduction in systolic blood pressure following propofol induction, identifying a cutoff of 1.05(7). In contrast, Toyama et al. found that higher preoperative PI values predicted post-spinal hypotension in parturients undergoing cesarean delivery, with a proposed cutoff of 3.5(11). These opposite results likely reflect differences in the underlying mechanisms of hypotension; vasodilation from propofol versus reduced peripheral vascular tone in pregnancy.

Thirunelli et al. assessed PI for predicting hypotension following propofol induction in non-cardiac surgeries. Using a baseline PI cut-off of 1.05, no correlation was found between PI and systolic, diastolic, or mean arterial pressure (12). Comparing the findings of Thirunelli et al. with those of Toyama et al. suggests that the mechanisms underlying hypotension may differ depending on the clinical context.

In our study, a baseline PI cutoff of 3.35 yielded a sensitivity of 82% and specificity of 60%, but baseline PI was not correlated with hypotension. Long-standing hypertension produces vascular remodeling and altered autoregulation, which may explain the discrepancy between our findings and those of previous research.

Propofol induces vasodilation by affecting both the autonomic nervous system and vascular endothelium(13, 14). Moderate vasodilation caused by anesthetic agents typically leads to an increase in PI(6, 14). Some antihypertensive drugs may potentiate propofol-induced hypotension. For example, angiotensin-converting enzyme inhibitors (ACEIs) increase nitric oxide activity and have been associated with a higher incidence of

hypotension under general anesthesia(15). Because our patient population used multiple antihypertensive agents with different mechanisms of action, the impact of these medications on PI could not be standardized, which may have influenced our findings.

Min et al. demonstrated that PI measured at the ear, but not the finger, predicted hypotension after anesthesia induction in hypertensive patients, suggesting that PI is affected by the measurement site relative to the heart(10). In our study, finger measurements were used, with the hand positioned at heart level to minimize positional effects.

The incidence of hypotension in our cohort was 22.8%. Sneyd et al. reported a higher rate (35%) in a meta-analysis, but their definition of hypotension (systolic blood pressure < 90 mmHg) and the longer procedural duration in their study may explain this difference(1). In our study, hypotension was defined as mean arterial pressure < 65 mmHg or a $> 30\%$ reduction in systolic blood pressure from baseline.

This study has some limitations. Invasive arterial monitoring was not performed, and non-invasive measurements were obtained at 3- to 5-minute intervals. Transient hypotensive episodes occurring between measurements may therefore have gone undetected. Additionally, the heterogeneous use of multiple antihypertensive agents limits the ability to determine the individual pharmacologic impact on PI. Future studies evaluating the effects of specific antihypertensive classes on PI, as well as the vascular alterations associated with long-standing hypertension, may provide further insights.

In conclusion, in hypertensive patients undergoing out-of-operating-room procedural sedation, the perfusion index measured at the finger is not a reliable predictor of propofol-induced hypotension. Further research is needed to identify alternative non-invasive markers capable of predicting hypotension in this population.

Declarations

Conflict of Interest

The authors declare that they have no conflict of interest

Author Contribution

Gulten K. Cakir: Conceptualization, Methodology, Investigation, Writing – Original Draft, Supervision; Gokhan Inangil: Formal analysis, Writing – Review & Editing; Temel Guner: Writing – Review & Editing, Methodology; Burcu Sari: Investigation, Data curation; Suheyla Abitagaoglu: Supervision, Writing – Review & Editing

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