ORIGINAL ARTICLE

# Perfusion Index as a Predictor of Hypotension Following Spinal Anesthesia in Lower Abdominal Surgery

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## Abstract

**Background:** Subarachnoid block (SAB) is a gold standard anesthetic technique for lower abdominal surgeries. Hypotension is a very common observation following a SAB. Perfusion index (PI) is a new parameter that can be used as a noninvasive method to find out the chances of developing hypotension after SAB.

**Aim and objective:** The aim and objective of this study was find out the relation between baseline PI and the likelihood of developing hypotension after SAB in lower abdominal surgeries.

**Materials and methods:** Our study was a prospective randomized observational study. In this study, patients were allocated in two groups according to the baseline PI. Group I includes patients with baseline PI ≤3.5 and group II includes patients with baseline PI > 3.5. Subarachnoid block with 15 mg 0.5% heavy bupivacaine at l4–l5 level or l3–l4 level intervertebral space was given and hypotension was mentioned as mean blood pressure <65 mm Hg.

**Results:** The hypotension in group I was 12.28% whereas in group II was 74.58%. The receiver operating characteristic (ROC) curve showed that baseline PI could be a useful parameter for detecting patients at risk of developing hypotension. The area under the ROC curve for the prediction of hypotension was 0.912. The specificity and sensitivity of PI (baseline) of 3.3 to find hypotension were 75.38 and 94.12%, respectively.

**Conclusion:** For predicting hypotension, PI can be used in patients having below umbilical surgeries under SAB. Therefore, it can be said that patients with PI (baseline) >3.5 have higher chances of developing hypotension than patients with PI <3.5.

**Keywords:** Hypotension, Perfusion index, Subarachnoid block.

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## Introduction

Subarachnoid block (SAB) is the gold standard anesthetic technique for lower abdominal surgeries. Hypotension is a very common observation following spinal anesthesia. Incidence of hypotension is 16–33% of non-obstetric and normotensive patients.[1,2] Following SAB principle physiological alteration is sympathetic blockade of preganglionic nerve fibers exiting the spinal cord from T1 to L2 results in decrease sympathetic tone.[3] The sympathetic fibers arising from T5–L1 are primarily responsible for maintaining the vasomotor tone.[3] Blocking these sympathetic nerve fibers results in vasodilation of the veins and pooling of blood in the lower extremities, thus a reduction in the effective circulatory blood volume and decrease in cardiac venous return causes a decrease in preload and cardiac output resulting in hypotension.[3] The vasodilatory changes depend on baseline sympathetic tone as well as the extent of the height of the block.[4] Perfusion index (PI) is a novel vital parameter that estimates the pulsatility of blood in the extremities, which depends upon the amount of red and infrared light absorption measured by a pulse oximeter.[5] The normal range of PI is 0.02% (very feeble strength) to 20% (very strong strength).[6–8] Pulse oximeters differentiate arterial blood from other components by a difference in transmitted light that passes through the flow of arterial blood. The non-pulsatile component includes blood in the venous compartment, connective tissues, and bone. Perfusion index compares the pulsatile blood flow to non-pulsatile blood flow in the peripheral vessels.[9–11] Perfusion index is reciprocally related to the vascular tone. A lower PI denotes a higher peripheral vascular tone. Therefore, increased incidence of reduction in blood pressure (BP) following SAB reflects the higher baseline PI. This study aimed to find the relation between baseline PI and hemodynamic changes after SAB in lower abdominal surgeries.

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**Conflict of interest:** None

## Materials and Methods

The prospective double-blinded observational study was performed on 120 patients fit for various elective lower abdominal surgeries under spinal anesthesia at Jawahar Lal Nehru Medical College and associated group of Hospitals, Ajmer approved from institution ethical committee with well-informed consent. The patients of ASA physical status class 1 and 2 in the age group of 20–60 years, of either sex who were planned for lower abdominal surgeries under SAB, were selected for our study. The study population was allocated into 2 groups with 60 patients in each group.

Group I ($n = 60$): With a baseline PI of ≤3.5. Group II ($n = 60$): With a baseline PI of >3.5. All patients included in the study were kept NBM for 8 hours. The procedure was explained to patients and their close relatives and informed written consent was taken. Intravenous (IV) access with optimum size i.v. cannula was secured in the forehand. Every patient was preloaded with 500 mL of Ringer lactate (RL) over 30 minutes.

Basic ASA monitoring with ECG, NIBP, and pulse oximetry ($SpO_2$) was applied. In our study, Schiller TRUSCOPE ultra-Q7 multipara monitor with specific pulse oximeter probe (Masimo SET rainbow®; Masimo Corp., Irvine, CA, USA) was used in all patients with ECG, NIBP in the right arm, PI was seen in the supine position in the right index finger. Baseline parameters were recorded after preloading. Under all aseptic precautions SAB was given by an anesthetist resident doctor unaware of the baseline PI values, SAB was given using Quincke's 25-G spinal needle in a sitting position with 15 mg (3 mL) of hyperbaric 0.5% bupivacaine at the L3–L4 or L4–L5 intervertebral space. Patients were made to lie in a supine position immediately after spinal anesthesia was given. Ringer lactate infusion was started and continued till the completion of surgery. Immediately after this, we started recording all parameters including PI at every 2 minutes for the first 20 minutes then every 5 minutes for 60 minutes by the same anesthetist who administered SAB.

Hypotension was defined as MAP <65 mm Hg and treated with an IV bolus of 6 mg drug mephentermine. The first 60 minutes after SAB was considered as anesthesia-induced hypotension. Bradycardia with heart rate <55 beats/minute was treated by giving injection atropine 0.6 mg IV bolus. The level of sensory blockade was checked 2 minutes after the spinal injection with the pin prick method. Patients who did not achieve T6 level sensory block were excluded from the study. The maximum cephalad height of the block was checked after 20 minutes of SAB. Motor block was checked by Modified Bromage scale.

Statistical analysis was carried out using Microsoft Excel and MedCalc software. Categorical data like age, sex weight, and height distribution were compared using the Shapiro–Wilk test, and categorical variables like frequency, the percentage was compared by Pearson's Chi-square test. Quantitative parametric data (numerical data) were analyzed using the Student's unpaired *t*-test. Receiver operating characteristics (ROC) curve was plotted between baseline PI and occurrence of hypotension among study subjects. A *p* value of <0.05 was considered statistically significant and <0.001 as highly significant.

## Observation

One hundred and twenty patients were assessed in the study. Four patients were excluded three in group I and one in group II due to inadequate level of the spinal block, for final analysis 57 patients were taken in group I and 59 patients were taken in group II. The demographic parameters, i.e., age, height, and weight were comparable between the two groups (Table 1).

**Table 1:** Comparison of demographic parameter in two groups

| *Demographic parameters* | *Group I (Mean ± SD)* | *Group II (Mean ± SD)* | *Unpaired t-test* |
|---|---|---|---|
| Age (years) | 41.98 ± 9.02 | 41 ± 10.07 | $t = 0.5515$, $p = 0.5824$, (>0.05) |
| Height (cm) | 168.56 ± 8.11 | 168.81 ± 8.09 | $t = 0.1662$, $p = 0.8683$, (>0.05) |
| Weight (kg) | 69.26 ± 9.18 | 72.44 ± 8.31 | $t = 1.9572$, $p = 0.0528$, (>0.05) |

**Table 2:** Comparison of gender distribution in two groups

| | *Group I (N = 57)* | | *Group II (N = 59)* | |
|---|---|---|---|---|
| | *No.* | *%* | *No.* | *%* |
| Male | 21 | 36.84 | 20 | 33.89 |
| Female | 36 | 63.15 | 39 | 66.10 |
| Total | 57 | 100.00 | 59 | 100.00 |
| Result (*p* value) | 0.891 (NS) | | | |

**Table 3:** Comparison of duration of surgery in two groups

| | *Group I (N = 57)* | | *Group II (N = 59)* | |
|---|---|---|---|---|
| | *Mean* | *SD* | *Mean* | *SD* |
| Mean duration of surgery (minute) | 84.67 | 17.96 | 84.98 | 18.31 |
| Median (minute) | 88 | | 86 | |
| Result (*p* value) | 0.925 (NS) | | | |

Gender distribution in both the group was comparable (Table 2).

Duration of surgery in both the group was comparable (Table 3).

Comparison in intraoperative heart rate in both the group was comparable (Figs 1 to 4).

Figure 5 shows that baseline systolic BP was comparable in both groups, but there was a significant decrease in systolic blood pressure in group II from 4 to 60 minutes.

Figure 6 shows that baseline diastolic BP was comparable in both groups, after SAB, there was a significant decrease in systolic blood pressure in group II from 2 to 60 minutes.

Figure 7 shows that baseline mean arterial pressure was comparable in both groups, after SAB there was a decrease in MAP in both the group but there was a significant decrease in MAP in group II from 4 to 60 minutes.

### Incidence of Hypotension

Table 4 shows that in group I 12.28% of patients develop hypotension while 87.72% of patients do not develop hypotension. In group II, 74.58 % of patients develop hypotension and 25.42% of patients do not develop hypotension. The incidence of hypotension in group II was significantly higher than in group I ($p < 0.0001$) (Fig. 8).

Receiver operating characteristic curve analysis between baseline PI and incidence of hypotension (Fig. 9).

### Area Under the ROC Curve (AUC)

| | |
|---|---|
| Area under the ROC curve (AUC) | 0.912 (95% CI = 0.845–0.957) |
| *p* value | 0.0001 (<0.001) |
| Parameters | Values at baseline PI >3.3 |
| Sensitivity | 94.12% (95% CI = 83.8–98.8%) |
| Specificity | 75.38% (95% CI = 63.1–85.2%) |
| Positive predictive value | 75.0% (95% CI = 66.1–82.2%) |
| Negative predictive value | 94.2% (95% CI = 84.4–98.0%) |

## Discussion

Hypotension following SAB for lower abdominal surgery is very common. Non-invasive blood pressure (NIBP) measurement is the basic method of monitoring intraoperative hemodynamics. Nevertheless, the lack of real-time beat-to-beat hemodynamics measurement by NIBP limits its effectiveness so that additional precautions may be required. Perfusion index is the ratio of pulsatile

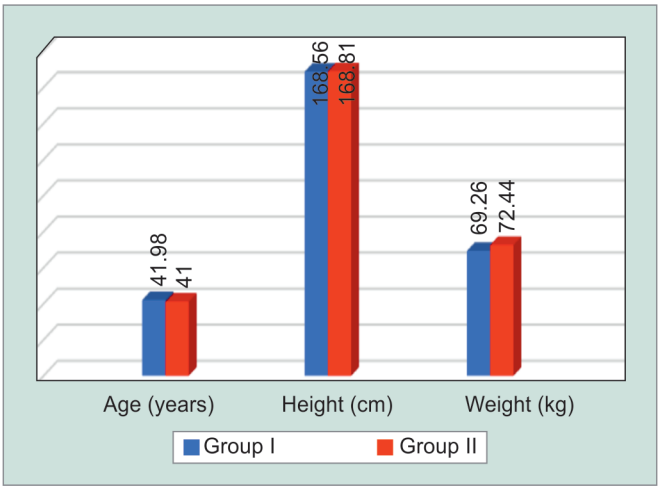


**Fig. 1:** Comparison of demographic parameters in two groups

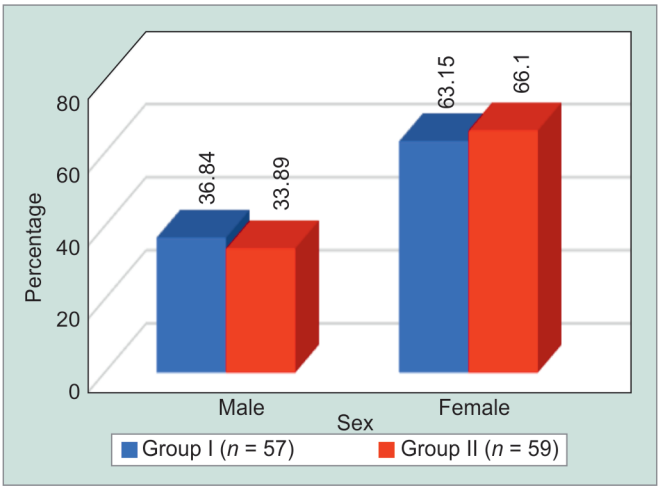


**Fig. 2:** Comparison of gender distribution between group I and group II

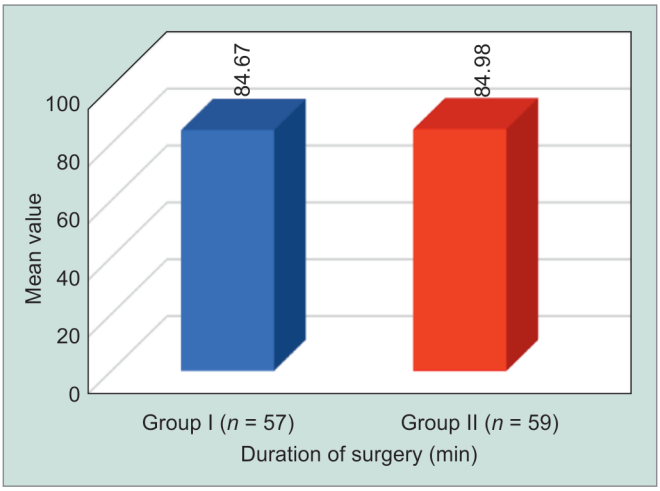


**Fig. 3:** Comparison of duration of surgery between group I and group I. Comparison in intraoperative heart rate in both the group was comparable

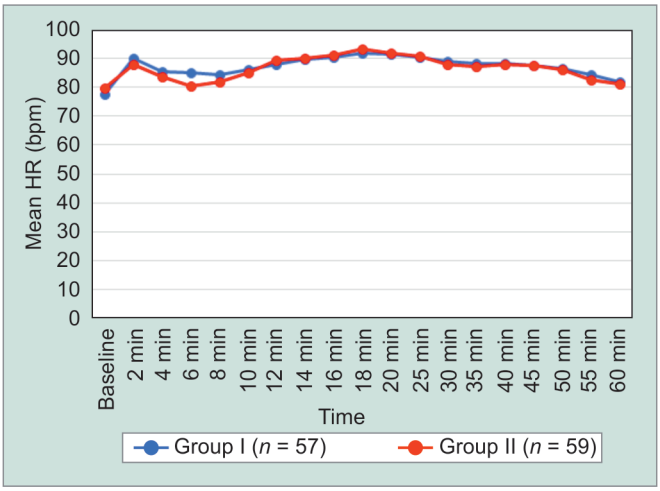


**Fig. 4:** Comparison of intraoperative heart rate between group I and group II

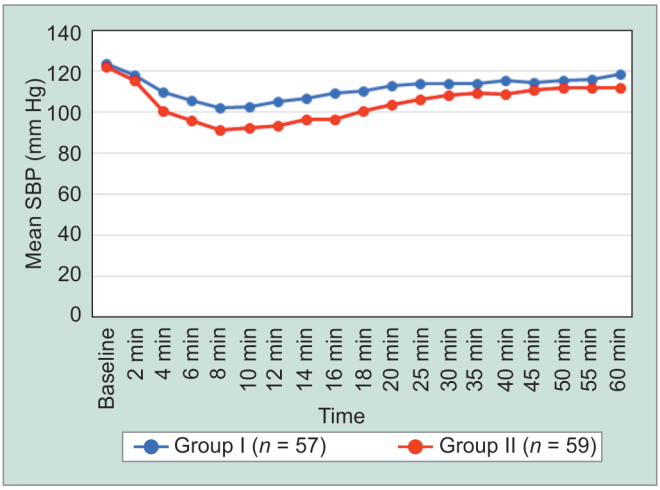


**Fig. 5:** Comparison of intraoperative systolic blood pressure between group I and group II

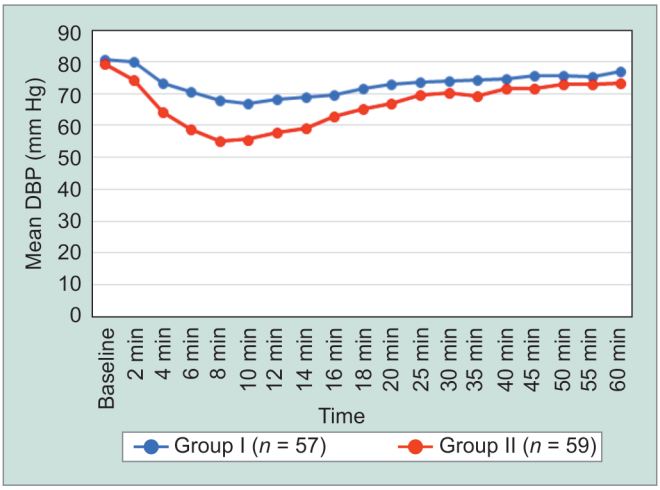


**Fig. 6:** Comparison of intraoperative diastolic blood pressure between group I and group II

blood flow to non-pulsatile blood flow in the peripheral vascular tissue.[10,11] Perfusion index is reciprocally related to the vessel tone. A lower PI denotes a higher peripheral vascular tone.

In our study, we demonstrated the likelihood of hypotension and variation in heart rate after SAB in lower abdominal surgeries using the PI. In our study, the likelihood of hypotension was higher in patients in group II with baseline PI values >3.5. The ROC curve conceded that PI differentiates well among patients who develop hypotension after SAB. In our study, a new baseline PI value of 3.3 was obtained from the ROC curve as the cut-off point for the prediction of hypotension in patients following SAB.

The cut-off point of baseline PI for prediction of hypotension after SAB was taken as 3.5 based on ROC curve analysis done by Toyama et al.[9] who suggested that a baseline PI point of 3.5 could be used to identify parturients at risk for hypotension. In the study by Ankita Gupta et al., the ROC curve suggested a baseline PI value of 3.1 as the cut-off point for predicting hypotension in patients under SAB in lower abdominal surgeries.[12]

In this study, the baseline PI >3.5 and the likelihood of hypotension were correlating significantly which is similar to the findings of studies done by Toyama et al. and Ankita Gupta et al.[9,12]

There were some limitations in this study. Movement of the patient and any stimulus leading to sympathetic stimulation like anxiety could alter the PI values.

During the study, PI values were recorded with extreme care to minimize the patient movement, particularly while recording baseline parameters and all participating patients were explained about the procedure before taking them up for surgery to alleviate anxiety. Since PI depends upon the vascular tone of peripheral vessels, its role is questionable in predicting hypotension in situations where the vascular tone is affected and thus more research is required before adopting it as a universal parameter to predict hypotension after SAB.[13] In addition, further research comparing PI with invasive and accepted tools for hemodynamic monitoring will enlighten its utility more.

## Conclusion

Perfusion index can be used as a predictor for hypotension in patients undergoing elective lower abdominal surgeries under SAB. Patients with baseline PI >3.5 (group II) are at higher risk of developing hypotension after SAB when compared with those with baseline PI ≤3.5 (group I).

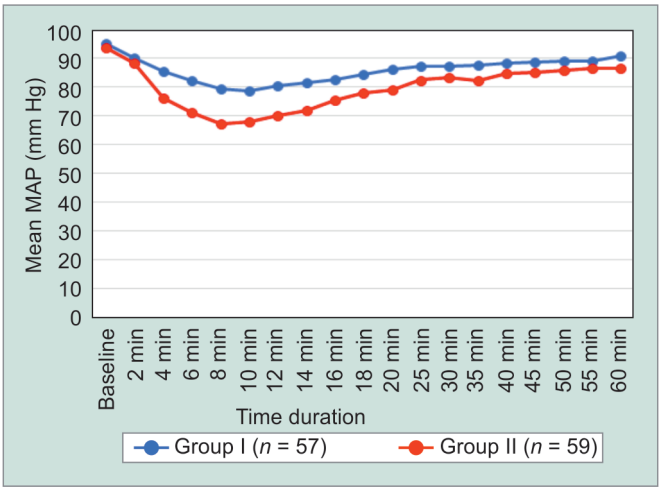


**Fig. 7:** Comparison of intraoperative mean arterial pressure between group I and group II

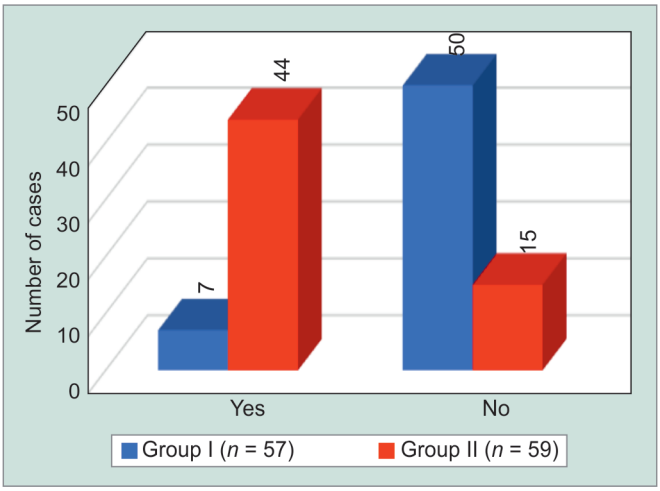


**Fig. 8:** Comparison of incidence of hypotension between group I and group II

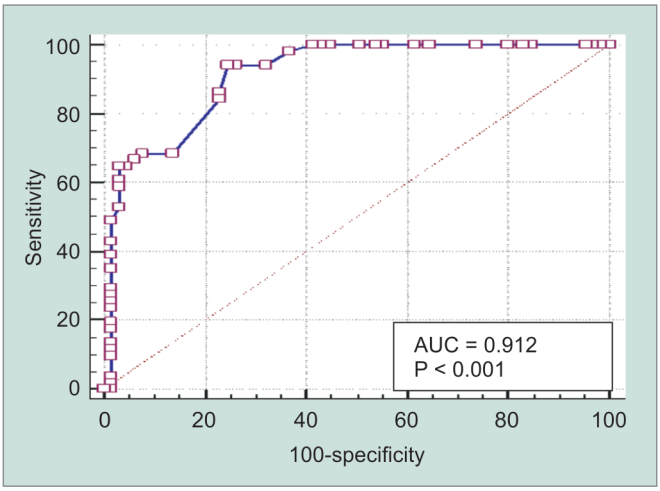


**Fig. 9:** ROC curve between baseline PI and incidence of hypotension

**Table 4:** Comparison incidence of hypotension in both groups

| | *Hypotension* | | | | |
|---|---|---|---|---|---|
| | *Yes* | *No* | *Total* | *Chi-square* | *p value* |
| Group I | 7 | 50 | 57 | 45.275 | <0.0001 (S) |
| (*n* = 57) | 12.28% | 87.72% | 100% | | |
| Group II | 44 | 15 | 59 | | |
| (*n* = 59) | 74.58% | 25.42% | 100% | | |

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