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A Study on Predicting Succesfull Sub Arachnoid Block Using Pulse Oximetry Perfusion Index.

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KEYWORDS
spinal block, perfusion index, prick test

ABSTRACT:

Aim: To analyse the role of perfusion index variations after performing regional anaesthesia in predicting a successful spinal anaesthesia.

Materials and methods: The study was conducted with a sample size of 100 patients, at Saveetha College of Allied Health Sciences (SCAHS) from August 2021 to February 2022. Following approval from the Institutional Review Board (IRB) and Ethical Committee Clearance, eligible patients were enrolled after obtaining written informed consent. Perfusion index (PI) measurements were recorded before regional anesthesia and at 1, 2, 3, 5, and 10 minutes after needle withdrawal to assess the role of PI variations in predicting a successful nerve block. A multiparameter patient monitor equipped with PI functionality will be utilized for data collection. Additionally, sensory responses to cold (ice test), tactile sensation, and motor function will be documented before regional anesthesia and at the specified time points post-needle withdrawal on the limb undergoing the block.

Results: At 1-minute post-needle withdrawal, the mean PI value was 1.847. As time progressed, there was a noticeable increase in PI values, with the mean PI reaching 3.681 at 3 minutes, 6.03 at 5 minutes, and 9.595 at 10 minutes post-needle withdrawal. At 1-minute post-needle withdrawal, the average level of sensory loss was 9.6. This level decreased to 6.1 at 3 minutes, then further decreased to 4.12 at 5 minutes, and remained relatively stable at around 4.0 from 10 to 15 minutes post-needle withdrawal.

Conclusion: PI has demonstrated utility in assessing the efficacy of spinal block procedures when compared to the pin prick test. However, the determination of cutoff values should be tailored individually and considered alongside the ascending trend in PI. Application of these study findings in the operating room setting may be beneficial for patients with limited compliance with the pin prick test. Spinal anesthesia induces differential blood flow distribution between blocked and unblocked areas. Toe PI increases in response to vasodilation after spinal anesthesia, often preceding and occurring more rapidly than the onset of anesthetic effects.

1. INTRODUCTION

The administration of subarachnoid blocks (SAB) is a common procedure in anesthesia, particularly for surgeries involving the lower abdomen, pelvis, and lower extremities. Despite its widespread use, achieving an optimal block with minimal complications remains a challenge for anesthesiologists.[1] The success of SAB depends on various factors such as patient anatomy, drug selection, injection technique, and individual responses to anesthesia. Early identification of the adequacy of block onset could significantly enhance patient outcomes and procedural efficiency. Pulse oximetry, a non-invasive monitoring technique routinely used in anesthesia, provides valuable physiological data, including oxygen saturation and heart rate. Recently, the concept of perfusion index (PI), derived from pulse oximetry, has gained attention as a potential predictor of peripheral perfusion and sympathetic tone.[2] The PI represents the ratio of pulsatile blood flow to non-pulsatile blood in peripheral tissues and has been explored in various clinical settings to assess perfusion status.

Despite its potential utility, the application of PI in predicting the success of SAB remains largely unexplored. This study aims to investigate the feasibility and effectiveness of using PI measurements obtained from pulse oximetry to predict the success of SAB. By correlating PI values with the onset and spread of sensory and motor blockade, we aim to develop a reliable indicator for assessing the adequacy of SAB in real-time.[3] The rationale for this study stems from the need for objective and quantitative measures to evaluate the efficacy of SAB. Current methods rely heavily on subjective assessment by the anesthesiologist, which may lead to variability in practice and delay in recognizing inadequate blocks. By incorporating PI monitoring into routine clinical practice, we anticipate earlier detection of block success or failure, allowing prompt adjustments in anesthesia management if necessary.[4] Furthermore, the potential benefits of utilizing PI in SAB extend beyond improving procedural outcomes. Early identification of inadequate blocks could reduce the risk of complications such as hypotension, incomplete anesthesia, and patient discomfort. Moreover, optimizing block efficacy may lead to better postoperative pain control and overall patient satisfaction.[5]

Investigating the predictive value of PI in SAB represents a novel approach to enhance perioperative care and anesthesia delivery. By harnessing the capabilities of pulse oximetry, we aim to provide an objective tool for assessing the success of SAB, ultimately improving patient safety and surgical outcomes.

2. METHODOLOGY

Study design: Randomized observational design.

Study subjects comprise patients undergoing lower abdominal and lower limb surgeries under spinal anesthesia.

Inclusion criteria	Exclusion criteria
• Individuals aged between 20 and 65 years. • Both male and female patients are eligible. • Patients classified as American Society of Anesthesiologists (ASA) physical status classification 1 and 2	• Patients with autonomic neuropathy. • Individuals with limb vascular abnormalities. • Subjects whose PI signal was lost during measurements are excluded from the study. • Patients with coagulation disorders. • Those categorized as ASA physical status classification 3 and 4. • Individuals diagnosed with peripheral vascular disease.

Sampling technique: Simple random sampling is utilized.

The study was conducted with a sample size of 100 patients, at Saveetha College of Allied Health Sciences (SCAHS) from August 2021 to February 2022. Following approval from the Institutional Review Board (IRB) and Ethical Committee Clearance, eligible patients were enrolled after obtaining written informed consent. Perfusion index (PI) measurements were recorded before regional anesthesia and at 1, 2, 3, 5, and 10 minutes after needle withdrawal to assess the role of PI variations in predicting a successful nerve block. A multiparameter patient monitor equipped with PI functionality will be utilized for data collection. Additionally, sensory responses to cold (ice test), tactile sensation, and motor function will be documented

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before regional anesthesia and at the specified time points post-needle withdrawal on the limb undergoing the block.

Data Analysis:

The acquired data were analyzed using IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp, Armonk, NY). Descriptive statistics will be used to summarize the demographic and clinical characteristics of the study population, including age, gender, ASA classification, and surgical procedure. Mean and standard deviation (or median and interquartile range, depending on data distribution) will be reported for continuous variables, while frequencies and percentages will be presented for categorical variables. Changes in PI measurements before regional anesthesia and at different time points post-needle withdrawal will be analyzed using repeated measures analysis of variance (ANOVA). Post-hoc tests (e.g., Bonferroni or Tukey) will be conducted to compare PI values at different time points. Pearson or Spearman correlation coefficients will be calculated to assess the correlation between PI variations and sensory/motor blockade outcomes. Sensory responses to cold (ice test), tactile sensation, and motor function before and after regional anesthesia will be compared using paired t-tests or Wilcoxon signed-rank tests. Differences in sensory and motor outcomes between patients with successful and unsuccessful nerve blocks will be analyzed using independent t-tests or Mann-Whitney U tests.A significance level of <0.05 was considered in all statistical analyses.

3. RESULTS

Figure 1 shows 1-minute post-needle withdrawal, the mean PI value was 1.847. As time progressed, there was a noticeable increase in PI values, with the mean PI reaching 3.681 at 3 minutes, 6.03 at 5 minutes, and 9.595 at 10 minutes post-needle withdrawal. This distribution suggests a temporal trend of increasing PI values over time following regional anesthesia administration. The progressive rise in PI may indicate improved peripheral perfusion and sympathetic tone, potentially reflecting the onset and spread of sensory and motor blockade associated with the anesthesia procedure.

Figure 1: Perfusion index over time in study participants

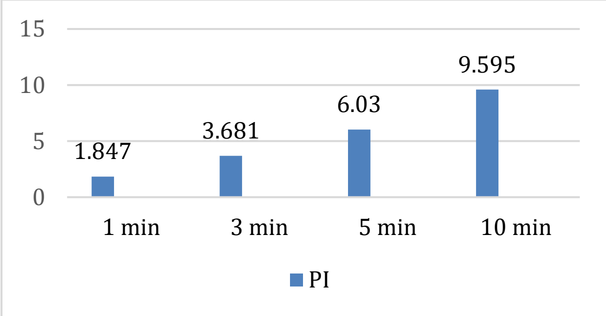


Figure 2 shows for loss of sensation to cold temperature: at 1-minute post-needle withdrawal, the average level of sensory loss was 9.6. This level decreased to 6.1 at 3 minutes, then further decreased to 4.12 at 5 minutes, and remained relatively stable at around 4.0 from 10 to 15 minutes post-needle withdrawal. For loss of sensation to pin prick: At 1-minute post-needle withdrawal, the average level of sensory loss was 8.22. This level decreased progressively over time, reaching 4.06 at both 10- and 15-minutes post-needle withdrawal. Overall, the table illustrates a decrease in sensory perception over time for both cold temperature and pin prick stimuli following regional anesthesia administration. This decrease in sensation indicates the onset and progression of sensory blockade associated with the anesthesia procedure. The sensory loss to pin prick seems to reach a plateau earlier compared to the loss of sensation to cold temperature, suggesting potential differences in the onset and duration of sensory blockade for different types of stimuli.

Figure 2: Loss of sensation to cold temperature and pin prick in the study participants

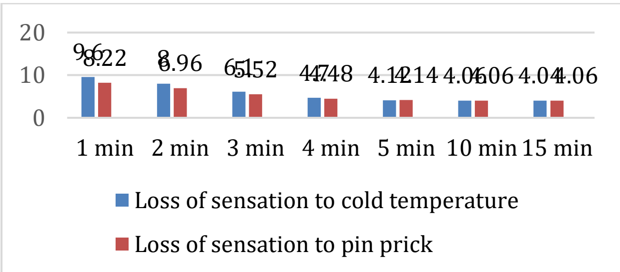
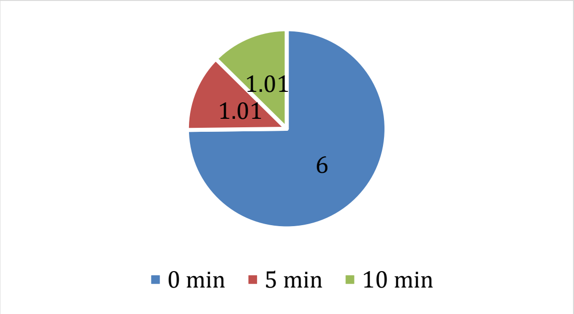


Figure 3 presents the distribution of Bromage scale scores at different time intervals following regional anesthesia administration. At 0 minutes post-needle withdrawal: The Bromage scale score was recorded as 6, indicating complete motor blockade with no ability to move the legs. At 5- and 10-minutes post-needle withdrawal: The Bromage scale score decreased to 1.01, suggesting partial recovery of motor function. A score of 1 on the Bromage scale typically indicates the ability to move the knees but not the feet. The figure indicates a reduction in motor blockade over time following regional anesthesia administration, as evidenced by the decrease in Bromage scale scores from complete paralysis to partial motor recovery. This progressive recovery of motor function suggests the gradual resolution of the effects of anesthesia on motor nerve transmission.

Figure 3: Bromage scale in the study participants



4. DISCUSSION

Hypotension following spinal anesthesia (SA) for lower segment cesarean section is a frequent occurrence, affecting not only parturients but also other patient populations.[6] Currently, there is a lack of a definitive monitoring system to predict the onset of hypotension following SA, necessitating additional precautionary measures. Our study observed a higher incidence and severity of hypotension, as well as an increased need for vasopressors, among parturients with baseline Perfusion Index (PI) values exceeding 3.5.

Normal pregnancy is characterized by a reduction in systemic vascular resistance, accompanied by an increase in cardiac output and total blood volume. This reduction in systemic vascular resistance varies among parturients due to multiple factors. The decline in vascular tone corresponds to elevated perfusion index values due to increased pulsatile components resulting from vasodilation.[7] Sympathectomy induced by SA further reduces peripheral vascular tone, leading to blood pooling and subsequent hypotension. Parturients with elevated baseline perfusion index values are expected to exhibit lower peripheral vascular tone, predisposing them to a higher risk of hypotension following SA. The threshold value for baseline perfusion index to predict SA-induced hypotension was determined as 3.5 based on a study by Toyama et al., which utilized regression analysis and ROC curve analysis.[8]

In our study, a baseline PI exceeding 3.5 demonstrated a significant correlation with the probability of hypotension, consistent with the findings of Toyama et al. [9] Their study reported a sensitivity and specificity of 81% and 86%, respectively, while our study showed a specificity of 65% and sensitivity of 67%. Notably, our study observed a higher consumption of intravenous fluids compared to Toyama et al.,[9] likely attributed to our use of injection ephedrine and fluid boluses for hypotension management, in contrast to their use of injection phenylephrine alone. Prostaglandins and methylergometrine, potent vasoconstrictors, were excluded from our analysis due to their potential influence on study observations. Duggappa DR et al. [10] also explored the predictive ability of perfusion index following SA in elective lower segment cesarean sections, finding a highly significant correlation between baseline PI exceeding 3.5, the number of hypotensive episodes, the total dose of ephedrine required, and the total IV fluids administered. Our study showed comparable sensitivity (67%) and specificity (65%) to their findings.

Additionally, Mowafi et al. [11] and Ginosar et al. [12] demonstrated the reliability of PI in detecting vasoconstriction following epidural anesthesia and sympathectomy, respectively. However, Yokose et al. found no predictive value of PI for hypotension in parturients undergoing cesarean sections following SA, potentially due to differences in fluid co-loading and hypotension definition compared to our study.

5. CONCLUSION

PI has demonstrated utility in assessing the efficacy of spinal block procedures when compared to the pin prick test. However, the determination of cutoff values should be tailored individually and considered alongside the ascending trend in PI. Application of these study findings in the operating room setting may be beneficial for patients with limited compliance with the pin prick test. Spinal anesthesia induces differential blood flow distribution between blocked and unblocked areas. Toe PI increases in response to vasodilation after spinal anesthesia, often preceding and occurring more rapidly than the onset of anesthetic effects. Therefore, placing a probe at the toe to objectively and non-invasively detect the early onset of spinal blockade can be valuable, with good sensitivity. A spike in PI indicates proper onset, while the absence of change serves as an early warning of anesthetic failure. Perfusion Index (PI) emerges as a potential tool for predicting hypotension in healthy parturients undergoing elective cesarean section under spinal anesthesia (SAB). Parturients with baseline PI exceeding 3.5 face an elevated risk of hypotension following SAB compared to those with baseline PI of 3.5 or less. Preoperatively measured baseline PI at the upper limb correlates with the extent of arterial pressure decline during subarachnoid block for cesarean delivery. A baseline PI cutoff of 3.5 can identify parturients at risk of hypotension. The incidence of hypotension doubles in the group with PI > 3.5 compared to PI ≤ 3.5. In conclusion, parturients with baseline PI exceeding 3.5 have a heightened susceptibility to hypotension following subarachnoid block compared to those with baseline PI of 3.5 or less.

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