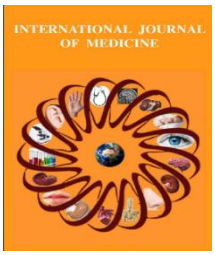

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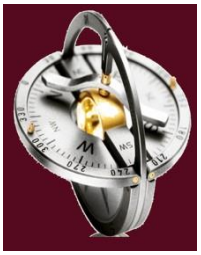

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Original Research

Evaluation of Perfusion Index as an Early Predictor of Successful Ultrasound-Guided Peripheral Nerve Block: A Prospective Observational Study.

Dr. Ajith Kumar R[1], Dr. Maddela Rithika[2], Dr. Vivekanand[3*]

1Senior Resident, Department of Anaesthesiology, Government Medical College, Yadadri Bhuvanagiri, Telangana, India.
2Senior Resident, Department of Anaesthesiology, Government Medical College, Quthbullapur, Medchal Telangana India.
3Senior Resident, Department of Anaesthesiology, Government Medical College Kamareddy, Telangana, India.

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Abstract

Background: Ultrasound-guided peripheral nerve block provides effective regional anaesthesia and postoperative analgesia. Conventional assessment of block success depends on sensory and motor testing, which is subjective, time-consuming, and difficult in sedated or poorly cooperative patients. Perfusion index, obtained from pulse oximetry, reflects peripheral vascular tone and can serve as an objective marker of sympathetic blockade. *Objectives:* To evaluate perfusion index as an early predictor of successful ultrasound-guided peripheral nerve block and to determine the diagnostic performance of early perfusion index changes. *Methods:* This prospective observational study included 100 patients undergoing ultrasound-guided peripheral nerve block at Gandhi Medical College, Secunderabad, Telangana, India, from October 2022 to September 2023. Perfusion index was recorded at baseline and at 5, 10, 15, and 20 minutes after block administration. Block success was assessed using standard sensory and motor criteria. Perfusion index values and 10-minute perfusion index ratio were compared between successful and failed or incomplete blocks. *Results:* Successful block was achieved in 88 patients, while 12 patients had incomplete or failed block. Baseline perfusion index was comparable between groups. Patients with successful block showed a progressive rise in perfusion index from 5 minutes onward. At 10 minutes, perfusion index was 4.28 ± 1.36 in successful blocks compared with 2.36 ± 0.81 in failed or incomplete blocks. A 10-minute perfusion index ratio of ≥1.5 showed 86.4% sensitivity, 83.3% specificity, and an area under the curve of 0.93. *Conclusion:* Early rise in perfusion index is a simple, non-invasive, and objective indicator of successful ultrasound-guided peripheral nerve block. The 10-minute perfusion index ratio showed excellent predictive performance.

Keywords: *Perfusion index; Peripheral nerve block; Ultrasound guidance; Pulse oximetry; Regional anaesthesia; Block success.*

Introduction

Peripheral nerve blocks are widely used in modern anaesthesia because they provide site-specific anaesthesia, reduce perioperative opioid requirement, and support postoperative analgesia. The use of ultrasound has strengthened the practice of regional anaesthesia by allowing direct visualization of neural structures, adjacent vessels, pleura, needle advancement, and local anaesthetic spread [1-3]. Compared with landmark-based techniques, ultrasound guidance offers better anatomical precision and helps reduce repeated needle passes, vascular puncture, and procedure-related discomfort [4,5]. Despite these advantages, the final success of a peripheral nerve block still depends on adequate neural blockade and timely identification of incomplete block before surgical incision.

In routine practice, block success is usually assessed by loss of cold, pinprick, or touch sensation and by reduction in motor power in the relevant nerve distribution. These methods are simple and clinically familiar, but they are subjective and require patient cooperation. Assessment becomes difficult in anxious, sedated, unresponsive, paediatric, or cognitively impaired patients. Repeated sensory testing also consumes operating room time and can delay surgical readiness. In addition, definitions of block success vary across clinical studies, which creates difficulty when comparing outcomes among regional anaesthesia trials [6]. Therefore, an objective, rapid, and non-invasive method for assessing block success has practical relevance.

Address for Correspondence Vivekanand, Senior Resident, Department of Anaesthesiology, Government Medical College Kamareddy, Telangana, India.
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The perfusion index is derived from the photoplethysmographic signal of a pulse oximeter and represents the ratio between pulsatile and non-pulsatile blood flow at the sensor site [7]. Successful peripheral nerve block produces sympathetic blockade before complete sensory and motor blockade. This sympathetic block causes vasodilatation, increased peripheral blood flow, and a rise in perfusion index in the blocked limb. Previous investigations have shown that perfusion index increases after epidural-induced sympathectomy and after successful regional block, supporting its biological plausibility as a marker of block onset [8,9]. The method is attractive because it is continuous, non-invasive, inexpensive, and available on many standard monitors.

Studies on brachial plexus and supraclavicular blocks have reported that early changes in perfusion index and perfusion index ratio can predict block success before complete clinical sensory and motor assessment [10-13]. However, cut-off values and the time point with the best diagnostic performance vary across studies. Receiver operating characteristic curve analysis is useful for assessing the discriminative ability of continuous diagnostic variables such as perfusion index [14]. The present study was conducted to evaluate perfusion index as an early predictor of successful ultrasound-guided peripheral nerve block. The primary objective was to compare serial perfusion index values between successful and failed or incomplete blocks. The secondary objective was to determine the diagnostic performance of early perfusion index values and the 10-minute perfusion index ratio for predicting successful block.

METHODOLOGY

Study design, setting and period: This prospective observational study was conducted in the Department of Anaesthesiology, Gandhi Medical College, Secunderabad, Telangana, India. The study period was from October 2022 to September 2023. The study followed routine clinical practice and did not alter the standard anaesthetic technique. Approval was obtained from the Institutional Ethics Committee before enrolment, and written informed consent was obtained from all participants.

Study population: A total of 100 adult patients scheduled for elective surgery under ultrasound-guided peripheral nerve block were included. Patients of either sex with American Society of Anesthesiologists physical status I or II were considered eligible. Patients with peripheral vascular disease, diabetes with clinically evident neuropathy, severe cardiovascular instability, local infection at the block site, allergy to local anaesthetic drugs, coagulopathy, failed pulse oximeter signal, or refusal to participate were excluded. Demographic details, ASA physical status, body mass index, and duration of surgery were recorded.

Block technique and perfusion index measurement: All blocks were performed under standard monitoring with electrocardiography, non-invasive blood pressure, and pulse oximetry. Ultrasound-guided peripheral nerve block was performed by an experienced anaesthesiologist using aseptic precautions and an appropriate high-frequency linear probe or curvilinear probe depending on the block site. Local anaesthetic type, volume, and concentration were selected according to institutional protocol and surgical requirement. Perfusion index was measured using a pulse oximeter probe placed on the limb receiving the block. Readings were recorded at baseline before block administration and at 5, 10, 15, and 20 minutes after completion of local anaesthetic injection. Perfusion index ratio at 10 minutes was calculated as perfusion index at 10 minutes divided by baseline perfusion index, in line with previous perfusion index studies [10-13].

Outcome assessment: Sensory block was assessed using response to pinprick or cold sensation in the relevant nerve distribution. Motor block was assessed using loss or reduction of movement appropriate to the blocked nerve territory. Block was considered successful when adequate sensory and motor blockade was achieved within the observation period and surgery proceeded without conversion to general anaesthesia or major rescue supplementation. Incomplete or failed block was defined as inadequate sensory or motor blockade requiring rescue supplementation, additional block, or alternative anaesthetic management.

Statistical analysis: Data were entered in a spreadsheet and analysed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as frequency and percentage. Perfusion index values were compared between successful and failed or incomplete block groups. A p-value less than 0.05 was considered statistically significant. Receiver operating characteristic curve analysis was used to identify the predictive performance of perfusion index values and perfusion index ratio for successful block [14]. Sensitivity, specificity, area under the curve, and 95% confidence interval were calculated.

Results

A total of 100 patients undergoing ultrasound-guided peripheral nerve block were included in the study. The mean age of the study population was 42.8 ± 12.6 years. Males constituted 58.0% of the participants, while females constituted 42.0%. Most patients belonged to ASA physical status I. The mean body mass index was 24.9 ± 3.5 kg/m². The mean duration of surgery was 92.4 ± 28.7 minutes. The baseline demographic and clinical characteristics of the study participants are shown in Table 1.

Table 1. Baseline characteristics of the study participants

Variable	Value
Total number of patients	100
Age, years	42.8 ± 12.6
Male	58 (58.0%)
Female	42 (42.0%)
BMI, kg/m²	24.9 ± 3.5
ASA physical status I	64 (64.0%)
ASA physical status II	36 (36.0%)
Duration of surgery, minutes	92.4 ± 28.7

Successful peripheral nerve block was achieved in 88 patients, giving an overall block success rate of 88.0%. Incomplete or failed block was observed in 12 patients. The mean onset time of sensory block was 11.6 ± 3.4 minutes, while the mean onset time of motor block was 16.8 ± 4.2 minutes. Rescue analgesia or supplementation was required in 12.0% of patients with inadequate block effect. Minor vascular puncture was observed in 2.0% of patients, while no patient developed local anaesthetic systemic toxicity, pneumothorax, or any major complication (Table 2).

Table 2. Block characteristics and outcome

Variable	Value
Successful block	88 (88.0%)
Incomplete/failed block	12 (12.0%)
Sensory block onset time, minutes	11.6 ± 3.4
Motor block onset time, minutes	16.8 ± 4.2
Requirement of rescue supplementation	12 (12.0%)
Vascular puncture	2 (2.0%)
Local anaesthetic systemic toxicity	0 (0.0%)
Pneumothorax/major complication	0 (0.0%)

The baseline perfusion index was comparable between patients with successful and failed blocks. However, patients with successful block

showed a progressive rise in perfusion index after the block. The increase was evident from 5 minutes and became more marked at 10, 15, and 20 minutes. In contrast, patients with failed or incomplete block showed only minimal change in perfusion index during the observation period. The difference between the two groups was statistically significant from 5 minutes onward (Table 3).

Table 3. Comparison of perfusion index between successful and failed block groups

Time interval	Successful block (n=88)	Failed/incomplete block (n=12)	p-value
Baseline PI	2.12 ± 0.74	2.04 ± 0.69	0.724
PI at 5 minutes	3.04 ± 1.02	2.21 ± 0.72	0.006
PI at 10 minutes	4.28 ± 1.36	2.36 ± 0.81	<0.001
PI at 15 minutes	4.86 ± 1.48	2.48 ± 0.86	<0.001
PI at 20 minutes	5.18 ± 1.52	2.56 ± 0.91	<0.001
PI ratio at 10 minutes	2.05 ± 0.68	1.17 ± 0.32	<0.001

The mean percentage increase in perfusion index at 10 minutes was significantly higher among patients with successful block compared with those with failed or incomplete block. A perfusion index ratio of ≥1.5 at 10 minutes showed good predictive ability for successful block, with sensitivity of 86.4% and specificity of 83.3%. The area under the receiver operating characteristic curve for the 10-minute perfusion index ratio was 0.93, indicating excellent diagnostic performance. Among the evaluated parameters, the 10-minute perfusion index ratio showed the best overall predictive performance (Table 4).

Table 4. Predictive performance of perfusion index for successful block

Parameter	Cut-off value	Sensitivity	Specificity	AUC	95% CI
PI at 5 minutes	≥2.8	78.4%	75.0%	0.82	0.72-0.91
PI at 10 minutes	≥3.2	84.1%	83.3%	0.88	0.79-0.96
PI ratio at 10 minutes	≥1.5	86.4%	83.3%	0.93	0.86-0.99
PI at 15 minutes	≥3.6	88.6%	83.3%	0.91	0.83-0.98

A statistically significant negative correlation was observed between the 10-minute perfusion index ratio and sensory block onset time, indicating that patients with a greater rise in perfusion index had faster sensory block onset. A similar negative correlation was also observed with motor block onset time. These findings suggest that an early rise in perfusion index after ultrasound-guided peripheral nerve block is associated with successful and earlier block establishment.

Overall, perfusion index demonstrated a consistent and clinically useful rise in patients with successful ultrasound-guided peripheral nerve block. Among the measured parameters, the 10-minute perfusion index ratio showed the best predictive performance and appeared to be a reliable early objective marker of block success.

Discussion

The present study evaluated perfusion index as an early objective predictor of successful ultrasound-guided peripheral nerve block in 100 patients. The overall block success rate was 88.0%, and successful blocks were associated with a clear and progressive increase in perfusion index after local anaesthetic injection. Baseline perfusion index was similar in both groups, but significant separation between successful and failed or incomplete blocks appeared from 5 minutes onward. This pattern supports the physiological concept that sympathetic blockade occurs early and produces vasodilatation before complete sensory and motor block is clinically evident [7-9].

The 10-minute perfusion index ratio showed the best diagnostic performance in this study, with an area under the curve of 0.93. This finding is clinically important because a reliable 10-minute marker can help the anaesthesiologist identify inadequate block before incision and before unnecessary delay. Galvin et al. reported that peripheral flow index was an early indicator of regional block success, while Kus et al. demonstrated a significant increase in perfusion index after successful infraclavicular block [9,10]. Similarly, Abdelnasser et al. found that perfusion index and perfusion index ratio were useful for predicting successful supraclavicular block, with strong diagnostic performance at 10 minutes [11].

The magnitude of perfusion index rise in the present study was lower than that reported in some earlier supraclavicular block studies, but the direction and clinical interpretation were consistent. Differences in block site, local anaesthetic volume, baseline vascular tone, ambient temperature, patient anxiety, limb position, and monitoring equipment can influence absolute perfusion index values. For this reason, the perfusion index ratio is useful because it normalizes the post-block value against the patient's own baseline value. Lal et al. also highlighted the value of perfusion index ratio in ultrasound-guided supraclavicular block and reported that it performed well as an objective indicator of block success [13].

The present study also found a negative correlation between 10-minute perfusion index ratio and sensory as well as motor onset time. This suggests that a faster and greater vascular response is linked to earlier clinical establishment of block. Kim et al. reported that epinephrine can influence perfusion index because of its vasoconstrictive effect, emphasizing the need to interpret perfusion index in the context of the local anaesthetic mixture used [12]. Therefore, standardization of drug composition, recording time points, limb temperature, and pulse oximeter placement is important when perfusion index is used for research or clinical decision-making.

From a practical viewpoint, perfusion index monitoring is simple, non-invasive, repeatable, and available through routine pulse oximetry. It does not replace sensory and motor testing in cooperative patients, but it provides an additional objective sign that is valuable when clinical assessment is delayed, uncertain, or unreliable. The findings of this study support its use as an adjunct for early block assessment in busy operating room settings. Larger multicentre studies with block-specific cut-off values can further strengthen its clinical utility.

Limitations

This study was conducted at a single centre with a moderate sample size, which limits external applicability. The blocks were evaluated over a short observation period and long-term analgesic outcomes were not assessed. Perfusion index was influenced by ambient temperature, anxiety, vasoactive drugs, and peripheral vascular tone, although standard monitoring conditions were maintained. Different peripheral nerve block sites were not analysed separately.

Conclusion

Perfusion index demonstrated a significant and progressive rise after successful ultrasound-guided peripheral nerve block. The increase was evident within 5 minutes and became more discriminative at 10 minutes. A 10-minute perfusion index ratio of ≥1.5 showed excellent predictive performance, with good sensitivity, specificity, and area under the curve. These findings indicate that perfusion index is a useful objective adjunct for early assessment of block success. It is simple, non-invasive, continuous, and available through routine pulse oximetry. Clinical sensory and motor assessment remains essential, but perfusion index can support faster recognition of successful or inadequate block in the operating room and improve perioperative decision-making without added procedural risk.

References

1. Marhofer P, Greher M, Kapral S. Ultrasound guidance in regional anaesthesia. Br J Anaesth. 2005;94(1):7-17. doi:10.1093/bja/aei002. PMID: 15277302.
2. Brull R, Perlas A, Chan VWS. Ultrasound-guided peripheral nerve blockade. Curr Pain Headache Rep. 2007;11(1):25-32. doi:10.1007/s11916-007-0018-6. PMID: 17214918.
3. Chin KJ, Chan V. Ultrasound-guided peripheral nerve blockade. Curr Opin Anaesthesiol. 2008;21(5):624-631. doi:10.1097/ACO.0b013e32830815d1. PMID: 18784490.
4. Neal JM, Brull R, Chan VWS, Grant SA, Horn JL, Liu SS, et al. The ASRA evidence-based medicine assessment of ultrasound-guided regional anesthesia and pain medicine: executive summary. Reg Anesth Pain Med. 2010;35(2 Suppl):S1-S9. doi:10.1097/AAP.0b013e3181d22fe0. PMID: 20216019.
5. Chan VWS, Perlas A, McCartney CJL, Brull R, Xu D, Abbas S. Ultrasound guidance improves success rate of axillary brachial plexus block. Can J Anaesth. 2007;54(3):176-182. doi:10.1007/BF03022637. PMID: 17331928.
6. Neal JM, Bernards CM, Hadzic A, Hebl JR, Hogan QH, Horlocker TT, et al. ASRA Practice Advisory on Neurologic Complications in Regional Anesthesia and Pain Medicine. Reg Anesth Pain Med. 2008;33(5):404-415. doi:10.1016/j.rapm.2008.07.527. PMID: 18774509.
7. Coutrot M, Joachim J, Depret F, Millasseau S, Mebazaa A, Gayat E, et al. Perfusion index: physical principles, physiological meanings and clinical implications in anaesthesia and critical care. Anaesth Crit Care Pain Med. 2021;40(6):100964. doi:10.1016/j.accpm.2021.100964. PMID: 34687923.
8. Ginosar Y, Weiniger CF, Meroz Y, Kurz V, Bdolah-Abram T, Babchenko A, et al. Pulse oximeter perfusion index as an early indicator of sympathectomy after epidural anesthesia. Acta Anaesthesiol Scand. 2009;53(8):1018-1026. doi:10.1111/j.1399-6576.2009.01968.x. PMID: 19397502.
9. Galvin EM, Niehof S, Verbrugge SJ, Maissan I, Jahn A, Klein J, et al. Peripheral flow index is a reliable and early indicator of regional block success. Anesth Analg. 2006;103(1):239-243. doi:10.1213/01.ane.0000220947.02689.9f. PMID: 16790660.
10. Kus A, Gurkan Y, Gormus SK, Solak M, Toker K. Usefulness of perfusion index to detect the effect of brachial plexus block. J Clin Monit Comput. 2013;27(3):325-328. doi:10.1007/s10877-013-9439-4. PMID: 23397432.
11. Abdelnasser A, Abdelhamid B, Elsonbaty A, Hasanin A, Rady A. Predicting successful supraclavicular brachial plexus block using pulse oximeter perfusion index. Br J Anaesth. 2017;119(2):276-280. doi:10.1093/bja/aex166. PMID: 28854539.
12. Kim D, Jeong JS, Park MJ, Ko JS. The effect of epinephrine on the perfusion index during ultrasound-guided supraclavicular brachial plexus block: a randomized controlled trial. Sci Rep. 2020;10(1):11585. doi:10.1038/s41598-020-68475-4. PMID: 32665656.
13. Lal J, Bhardwaj M, Malik A, Bansal T. A study to evaluate the change in perfusion index as an indicator of successful ultrasound-guided supraclavicular block. Indian J Anaesth. 2021;65(10):738-743. doi:10.4103/ija.ija_553_21. PMID: 34898700.
14. Nahm FS. Receiver operating characteristic curve: overview and practical use for clinicians. Korean J Anesthesiol. 2022;75(1):25-36. doi:10.4097/kja.21209. PMID: 35124947.