Original Research Paper

Volume - 16 | Issue - 02 | February - 2026 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Anaesthesiology

A STUDY TO EVALUATE THE CHANGES IN PERFUSION INDEX AS AN INDICATOR OF SUCCESSFUL ULTRASOUND GUIDED SUPRACLAVICULAR BLOCK" IN TERTIARY CARE HOSPITAL.

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ABSTRACT

Background And Aim: Perfusion index (PI) is a new simple, objective and non-invasive method for evaluation of the success of central neuraxial and peripheral nerve blocks. So, we conducted a study with an aim to evaluate PI as an indicator for success of ultrasound-guided supraclavicular block (SCB). **Methods:** This study was a cross sectional observational study.100 patients of either sex, age 18–60years, American Society of Anesthesiologists physical status I and II posted for upper limbsurgery under ultrasound (US)-guided SCB were included.The study was conducted in osmania general hospital.PI was recorded at baseline every 2 minutes till 10 minutes and then every 5 minutes till 30 minutes after block. PI ratio was calculated as the ratio between PI at 10 minutes and baseline PI. Sensory and motor blocks were assessed at 5-minutes intervals up to 30 minutes. **Results:** Mean PI increased continuously from baseline and reached the maximum at 10 minutes and then slightly decreased up to 30 minutes, but values at subsequent time intervals were quite high as compared to baseline. In case of successful blocks, median PI started increasing 2minutes after the block and then increased in a linear fashion till 10 minutes, whereas in case of failed blocks, it only increased minimally. **Conclusion:** PI is an objective and faster indicator for evaluating success of US-guided SCB.A mean PI exhibited incremental increases, with values ranging from 4.18 at baseline to 9.03 at 30 minutes,reflecting a progressive improvement in tissue perfusion.

KEYWORDS : Brachial plexus block, perfusion index, peripheral nerve block, ultrasound guided supraclavicular

INTRODUCTION:

Regional anaesthesia [1] offers benefits for the patients, surgeons and anaesthesiologists because of its inherent simplicity, preservation of consciousness, voidance of airway instrumentation, rapid recovery, prevention of undesirable effects of general anaesthetic drugs and improved postoperative analgesia. Brachial plexus block is considered to be a good alternate procedure to general anaesthesia to achieve analgesia of upper limb. Brachial plexus block can be performed at various levels namely interscalene, supraclavicular, infraclavicular block and axillary block. Supraclavicular approach [2] is considered to better approach than other levels because brachial plexus is more compact and superficial in this region and is easy to approach.The major advantage of using ultrasound-guided nerve block[2] is that it reduces dense analgesia and anaesthesia with minimum dose of local anaesthetics. Onset of achieving anesthesia and analgesia is also rapid.The success of peripheral nerve block is usually assessed using neurological examination by performing sensory and motor test.However, this neurological assessment has its own limitation. Subjective nature of neurological assessment depends on patients understanding and perception. It also needs cooperation from the patient and s a time-consuming process. It can be done only when the patient is awake and able to give feedback and cannot be performed in patients who are under general . A successful peripheral nerve block (PNB) [3] would result in blockade of sympathetic nerve fibers and causes a few physiological changes including vasodilation which leads to increase in blood flow to that area and increase in temperature.Many assessment methods have been studied in various research works to improve the objectivity of assessing adequate nerve block in peripheral nerve block procedures. The range of assessment methods and monitoring includes skin temperature measurement, monitoring skin electrical resistance, tissue oxygen saturation, laser doppler perfusion imaging and perfusion index[4].Of the above-mentioned techniques for detection of success of nerve blockade, perfusion index is a simple, non-invasive and easy method which would aid in rapid interpretation of successful block. Hence the recent study as done to identify the ability of perfusion index[4] in predicting the success of supraclavicular brachial plexus block.When the block is successful, there would be sympathetic autonomic blockade in the blocked arm which in turn causes vasodilation and increase in blood flow leading to high perfusion index compared to unblocked arm. Thus, relative change in Perfusion Index (PI) and Perfusion Index Ratio (PIR) over a period of time could be used as a reliable marker to predict success of the block.

MATERIALS AND METHODS:

Study: This is cross sectional observational study

Settings: Osmania General Hospital, Afzalgunj,Hyderabad.

Inclusion Criteria:

1) ASA grade 1 an 2.
2)18 to 65 years of age.
3) Both male and female who gave informed and written consent.
4)Patients posted for upper limb surgery.

Exclusion Criteria:

1)Patients with diabetes mellitus,peripheral vascular disease.
2)Patients having known allergy either to local anaesthetics,use of alpha and beta blockers.
3)Patients having local site infection.
4)Patient refusal or inability to understand procedure.

A total of 100 patients undergoing elective surgery were selected for the study. All the patients were assessed and those with normal clinical, biochemical, radiological, and hematological parameters were selected. Informed written consent was obtained from patients. A thorough pre anesthetic evaluation was done including history and general examination. Procedure was explained to the patient and informed consent was obtained. All 100 patients were advised to remain nil per oral for 8 hours for solids,2 hours of clear liquid. Before performing the procedure 18-gauze venous cannula was secured in opposite hand and ASA standard monitors like pulse oximetry, non invasive blood pressure , electrocardiogram were attached, and baseline readings were noted. Injection midazolam, intravenous (IV) 1 mg was given to all patients.The procedure was done in supine position with arm adducted. Ultrasound-guided supraclavicular brachial plexus block was performed under strict aseptic precautions with 22-gauge echogenic needle using linear probe 8 to 12 Hz of ultrasound machine. Patient received 10 ml of 2 percent lignocaine and 20 ml of 0.5 percent bupivacaine after negative aspiration for blood/air.The limb was evaluvated for block success every 5 minutes for the sensory block and motor block. Sensory function was assessed using pinprick in the dermatomal areas supplied by the four main nerves median rve, radial nerve , ulnar nerve, and musculocutaneous nerve. Motor block was assessed by the ability to flex the elbow and lift the hand against gravity. The supraclavicular considered successful with regard to neurological examination if brachial plexus dermatomes (C5–T1) were completely blocked.Patient's hemodynamic variable like heart rate(HR), systolic blood pressure, diastolic blood pressure, an oxygen saturation (SpO2) were monitored every 5 minutes. PI was measured using pulse oximetry applied on the index finger. PI was evaluated at baseline at every 2minutes till 10 min then every 5min till 30min after block . PI BASELINE, 2 ,4 ,6,8,10,15, 20,25 and 30 minutes after local anaesthetic injection in both the blocked limb and the contralateral unblocked limb using two separate pulse oximeters. PI ratio, i.e., PI at 10 minutes to PI at baseline was also calculated in every patient and comparison between blocked n unblocked limb was performed.

Statistical Analysis:

Statistical analysis was conducted utilizing SPSS version 26, where continuous variables were evaluated for means and standard deviations, while categorical were assessed for frequencies and percentages. The association between categorical variables was examined using the chi-square test. The Shapiro-Wilk test was employed to ascertain the normal distribution of the data. To explore the relationship between two continuous variables, the independent t-test was utilized. Receiver Operating Characteristic (ROC) curves were generated, and sensitivity, specificity, as well as positive and negative predictive values, were computed. A significance level of p ≤0.05 was deemed statistically significant

Perfusion Index Based On Block Status

PERFUSION INDEX	SUCCESSFUL		FAILED		P-Value
	MEAN	SD	MEAN	SD	
BASELINE	4.55	2.104	1.48	1.364	<0.001
2 MINS	5.62	2.703	1.66	0.620	<0.001
4 MINS	6.01	2.363	2.02	0.473	<0.001
6 MINS	6.60	2.537	2.12	0.506	<0.001
8 MINS	7.88	2.545	2.30	0.531	<0.001
10 MINS	8.39	2.466	2.46	0.562	<0.001
15MINS	8.67	2.790	2.79	0.454	<0.001
20 MINS	8.75	2.897	3.15	0.635	<0.001
25 MINS	9.81	2.552	3.26	0.703	<0.001
30 MINS	9.53	2.529	3.40	0.837	<0.001

Independent t test

P≤0.05 is statistically significant. At baseline, participants with successful blocks exhibit a mean perfusion index of 4.55 (SD = 2.104), whereas those with failed blocks demonstrate a notably lower mean of 1.48 (SD = 1.364), representing a statistically significant difference ($p < 0.001$). This trend persists consistently throughout the study duration, with participants in the successful block group consistently showing higher mean perfusion index values compared to their counterparts in the failed block group.At 2 minutes post-intervention, the mean perfusion index for successful blocks is 5.62 (SD = 2.703), significantly higher than the mean of 1.66 (SD = 0.620) observed in the failed block group ($p < 0.001$). Similarly, at 4 minutes, participants with successful blocks have a mean perfusion index of 6.01 (SD = 2.363), whereas those with failed blocks have a mean of 2.02 (SD = 0.473) ($p < 0.001$).This pattern persists throughout the study, with statistically significant differences observed at all time intervals: 6 minutes (successful: Mean = 6.60, SD = 2.537; failed: Mean = 2.12, SD = 0.506, $p < 0.001$), 8 minutes (successful: Mean = 7.88, SD = 2.545; failed: Mean = 2.30, SD = 0.531, $p < 0.001$), 10 minutes (successful: Mean = 8.39, SD = 2.466; failed: Mean = 2.46, SD = 0.562, $p < 0.001$), 15 minutes (successful: Mean = 8.67, SD = 2.790; failed: Mean = 2.79, SD = 0.454, $p < 0.001$), 20 minutes (successful: Mean = 8.75, SD = 2.897; failed: Mean = 3.15, SD = 0.635, $p < 0.001$), 25 minutes (successful: Mean = 9.81, SD = 2.552; failed: Mean = 3.26, SD = 0.703, $p < 0.001$), and 30 minutes (successful: Mean = 9.53, SD = 2.529; failed: Mean = 3.40, SD = 0.837, $p < 0.001$).

These findings underscore the significant impact of block status on tissue perfusion dynamics, with successful blocks associated with consistently higher mean perfusion index values compared to failed blocks across all time points.

Perfusion Index Ratio Based On Block Status

Perfusion Index Ratio	MEAN	SD	P- Value
SUCCESSFUL	5.74	3.699	0.004
FAILED	1.55	1.617	

Independent T Test

P≤0.05 is statistically significant

For participants with successful blocks, the mean perfusion index ratio is reported as 5.74 ±3.699, suggesting a relatively higher increase in tissue perfusion compared to baseline. Conversely, participants with failed blocks exhibit a slightly lower mean ratio of 1.55±1.617. The p-value associated with the independent t-test comparing the perforation index ratio between the two groups is reported as 0.004, indicating statistical significance

Receiver Operating Characteristics For The Ability Of The Perfusion Index To Detect Block Success

It presents the receiver operating characteristics (ROC) for the ability of the perfusion index to detect block success, highlighting the diagnostic performance at specific time points and using perfusion index ratios. At 10 minutes post-intervention, the perfusion index demonstrates a sensitivity of 65.2% and a specificity of 68%, with a positive predictive value (PPV) of 82.1% and a negative predictive value (NPV) of 49.4%. This indicates that while the perfusion index at this time point is reasonably good at predicting successful blocks (PPV), its ability to rule out failures (NPV) is more limited. In contrast, the perfusion index ratio shows excellent diagnostic performance, with a sensitivity of 96.67% and a perfect specificity of 100%, yielding a PPV of 100% and an NPV of 71.44%. These findings suggest that the perfusion index ratio is a highly reliable metric for detecting block success, significantly outperforming the perfusion index at the 10-minute mark. The superior sensitivity and specificity of the perfusion index ratio underscore its potential utility as a robust diagnostic tool in clinical practice.

VARIABLES	Sensitivity	Specificity	PPV	NPV
Perfusion Index at 10 Minutes	65.2%	68%	82.1%	49.4%
Perfusion Index Ratio	96.67%	100%	100	71.44

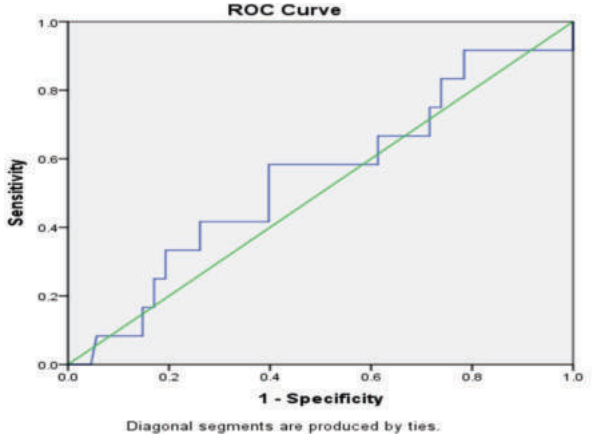

Figure 1: ROC Curve For Pi At 10minutes

Figure 1 illustrates the Receiver Operating Characteristic (ROC) curve for the perfusion index (PI) at 10 minutes post-intervention. The Area Under the Receiver Operating Curve (AUROC) for the perfusion index at this time point is 0.544, with a 95% Confidence Interval (CI) ranging from 0.367 to 0.721, and a p-value of 0.022.

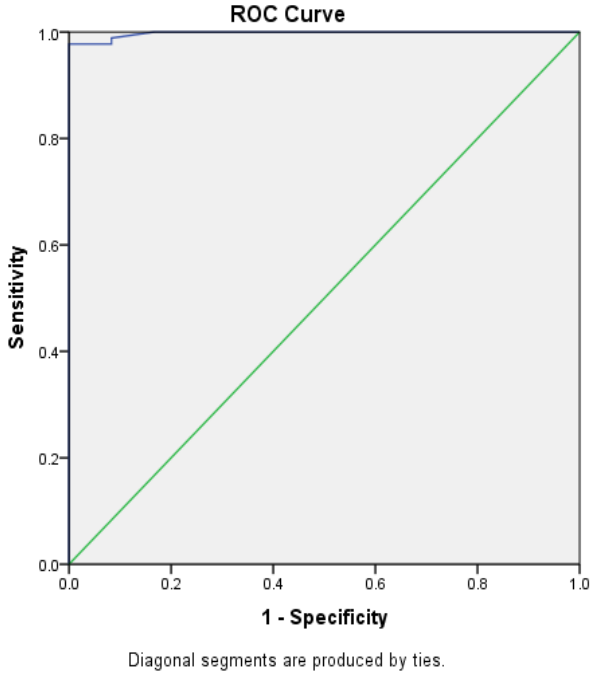

Figure 2: ROC Curve For Perfusion Index Ratio

Figure 2 illustrates the Receiver Operating Characteristic (ROC) curve for the perfusion index ratio (PIR). The Area Under the Receiver Operating Curve (AUROC) for the perfusion index at this time point is

0.998, with a 95% Confidence Interval (CI) ranging from 0.992 to 1.000, and a p-value of 0.003.

CONCLUSION:

In conclusion, the investigation highlights the potential utility of perfusion index (PI) and perfusion index ratio (PIR) as objective metrics for evaluating the efficacy of ultrasound-guided supraclavicular nerve blocks. Through a methodologically rigorous approach and comprehensive statistical analysis, the study elucidates the diagnostic significance of these measures in assessing peripheral perfusion dynamics post-procedure.

Acknowledging inherent limitations, including the single-center design and restricted follow-up duration, future research endeavors should prioritize multicenter collaborations, extended longitudinal assessments, and rigorous validation studies.

Nonetheless, the study underscores the transformative potential of PI and PIR in enhancing perioperative care paradigms, facilitating informed clinical decision-making, and optimizing patient outcomes in ultrasound-guided supraclavicular nerve block procedures. Continued exploration of these measures' clinical applications holds promise for advancing anesthesia delivery standards and ensuring patient safety in diverse surgical settings.

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