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DETECTION OF SUCCESSFUL SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK BY PULSE OXIMETER PERFUSION INDEX

Anaesthesiology

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ABSTRACT

Background: Early and accurate detection of failure of supraclavicular brachial plexus block helps to take early corrective measures and thus to save the operating room time and improve patient satisfaction.

Aims: To assess the efficacy of perfusion index and perfusion index ratio in prediction of success or failure of brachial plexus block by supraclavicular approach.

Methods: Ninety adult patients scheduled for upper limb surgery under supraclavicular brachial plexus block were recruited in this study. Success of brachial plexus was assessed by using traditional methods such as loss of pin prick and thermal sensation. Perfusion index and perfusion index ratio was monitored in both limbs at baseline, 3, 6, 9, 12, 15, 18 and, 21 minutes after block. Changes in PI and PI ratio were measured in successful as well as failure cases of brachial plexus block.

Results: Significant increase in perfusion index (1.60 Vs 7.65) and perfusion index ratio (1.00±0.00 Vs 4.78±2.7) was noticed following successful block. PI and PI ratio may be an important tool for early prediction of success rate of brachial plexus block. Failure or partial block was noticed in eight patients.

KEYWORDS

Brachial plexus block; Supraclavicular route; Prediction of successful block; Perfusion Index, Perfusion Index ratio

INTRODUCTION:

Brachial plexus block by supraclavicular approach provides excellent anesthesia and postoperative analgesia of entire upper limb. Use of nerve locator and ultrasound has improved the success rate but failure or incomplete block is not rare following supraclavicular plexus block.[1,2] Detection of success or failure of such block takes considerable time using traditional method of pin prick. If sensation is intact, this may be unpleasant and rapidly destroy patient confidence.

Early and accurate detection of failure of brachial plexus block would enable rapid corrective action either by block supplementation or switching to general anesthesia. This would save the operating room time and improves patient satisfaction. Perfusion index has been suggested as a tool for an early and accurate detection of regional blocks.[3,4]

The perfusion index is a numerical value for the ratio between pulsatile and non-pulsatile blood flow measured by a special pulse oximeter. It is an indication of the pulse strength at the sensor site. Perfusion index (PI) increases following vasodilatation caused by sympathectomy. It provides an earlier and clear indication of sympathectomy following epidural anesthesia.[4] Kus A and co-workers[3] reported that perfusion index is a highly valuable tool for detection of success of regional anesthesia of upper extremity. Based on these observations present study was designed;

- To evaluate the efficacy of perfusion index in prediction of success or failure of supraclavicular brachial plexus block.
- To assess whether success of supraclvicular block can be determined earlier by the PI and PI ratio than the conventional method.

MATERIALS AND METHODS:

After obtaining clearance from Institutional Ethics Committee and informed consent from 90 patients scheduled from upper limb surgeries under brachial plexus block were recruited in this randomized prospective study. ASA I and II adult patients (18 yrs -60 yrs) of either sex were included in this study. Patients with co-morbid diseases such as peripheral vascular disease, peripheral neuropathy, allergic to study drugs and require bilateral limb surgeries were excluded from the study.

Sample size was calculated to detect an area under the receiver operating characteristic (AUROC) curve of 0.8 with null hypothesis with AUROC curve of 0.5. Failure rate of supraclavicular block was considered as 10%. A minimal of 80 patients with 8 failed blocks was required to obtain a study power of 80% and alpha error of 0.05.

Initially one hundred and eleven (111) patients were recruited for the study of which nine (9) patients refused to take part in the study and eleven (11) patients did not fulfill the inclusion criteria. One (01) patient was excluded as he was allergic to the study drugs. Finally ninety patients (90) were selected for the study. The statistical calculation was done on eighty two (82) patients as there were eight (8) failed blocks.

Patients were premedicated with oral diazepam 10 mg and omeprazole 40 mg orally night before surgery. Standard fasting guidelines were followed. Patients were placed on the operation table and all monitors were attached to record baseline parameters. Intravenous cannulation was established for per operative fluid therapy. Probes of Philips Multiparameter Spo2 monitor Intellivue MX500 applied on the index fingers of both hands and perfusion index was noted down.

Patients were placed in the supine position with the head turned away from the side to be blocked. The supraclavicular brachial plexus blocks were performed by following anatomical landmarks. After aseptic skin preparation, one 22 gauge insulated needle was inserted immediately superior to the midclavicular point and gradually advanced caudally. The nerve locator is attached to insulated needle to locate brachial plexus. After identification of the proper plane, 30 ml of 0.5% bupivacaine hydrochloride was injected.

After brachial plexus block, perfusion index was measured at 3, 6, 9, 12, 15, 18 and 21 minutes in both operating and non-operating upper limbs using two separate oximeters. Pin prick and thermal sensation (using alcohol soaked cotton swab) were assessed at an interval of 3 minutes to find out onset of brachial plexus block.

At the end of the study period surgical team was allowed to start surgical procedures.

Statistical Analysis:

Data were analyzed using SPSS (Statistical Package for Social Scientists) version 20.0, IBM, USA and were presented in tables. Repeated Measures ANOVA test was done to compare the difference in means of the various parameters over the observed time period. Bonferroni test was used as post-hoc test. A "p" value of ≤ .05 was considered statistically significant.

RESULTS:

Based on the inclusion and exclusion criteria, 90 patients were recruited for this study. Perfusion index of all patients were recorded

for subsequent analysis. Failure or partial block was noticed in 8 patients detected by traditional method of loss of sensation to pin prick and thermal stimulus. Finally eighty-two patients with successful block were recruited in this study, observations were compiled and, the results were analyzed statistically.

Among the 82 patients, Open reduction and internal fixation of arm were most commonly performed, followed by TENS removal and plating of humerus. Most of the patients were between 30-49 yrs old. Male female ratio was 42:40

Repeated Measures ANOVA test was done to compare the difference in means of the Mean arterial pressures (MAP) over the observed time period. The Mean MAP at different points of time (3, 6, 9, 12, 15, 18, and 21 minutes) did not vary significantly [F = 1.137 p = 0.338] from the preoperative baseline MAP.

Table 1: Perfusion Index (PI) of patients (n=8) with failed brachial plexus block

S No	Time in minutes	Mean Perfusion Index	
		Anaesthetised Hand	Non-Anaesthetised Hand
1	Base line	1.60	1.59
2	3	1.62	1.58
3	6	1.66	1.60
4	9	1.57	1.61
5	12	1.60	1.68
6	15	1.96	1.64
7	18	1.91	1.51
8	21	1.90	1.60

Mean perfusion index of 8 patients with unsuccessful brachial plexus block were compared and insignificant changes were observed (Table 1) ($p > 0.05$).

Table 2: Perfusion Index (PI) Of Patients With Successful Brachial Plexus Block

S No	Time in minutes	Mean Perfusion Index (SD)	
		Anaesthetised Hand	Non-Anaesthetised Hand
1	Base line	1.60 (1.01)	1.58 (1.12)
2	3	2.26 (1.11)	1.58 (0.98)
3	6	3.40 (1.01)	1.60 (1.02)
4	9	4.27 (1.21)	1.61 (1.11)
5	12	4.98 (1.31)	1.68 (0.97)
6	15	6.27 (1.56)	1.40 (1.23)
7	18	6.98 (1.67)	1.51 (1.12)
8	21	7.65 (1.31)	1.60 (1.13)

Base line perfusion indexes of remaining 82 patients with successful block were comparable between anaesthetized and non-anesthetized hand. Following brachial plexus block gradual increase in perfusion index was noticed at anaesthetized hand (table 2). Significant increase of perfusion index was noticed at 9 minutes onward ($p < 0.05$). No significant change was observed at non-anaesthetised hand.

Table 3: Variation of Perfusion Index Ratio (PIR) Following Brachial Plexus Block

Time of observation	Perfusion Index Ratio		Number of patients
	Mean	Standard Deviation	
baseline	1.00	0.00	82
3 mins	1.41	1.17	82
6mins	2.13	1.59	82
9mins	2.67	1.45	82
12 mins	3.11	0.99	82
15 mins	3.92	1.66	82
18 mins	4.36	1.90	82
21 mins	4.78	2.70	82

Mean PIR increased significantly from 9 minutes on wards (4th observation) [F=62.87, P=0.00]

PIR was calculated from PI at different time points divided by PI at baseline. F is ANOVA value.

(Greenhouse-Geisser correction)

Based on estimated marginal means: a) The mean difference is significant at the .05 level and b) Adjustment for multiple comparisons, Bonferroni.

DISCUSSION:

Brachial plexus block is the commonest block to provide anaesthesia for upper limb surgery. Supraclavicular approach is the most preferred technique because by supraclavicular approach, brachial plexus is blocked at the distal trunk and proximal division level.

Use of nerve locator or ultrasound has improved the success rate but failure or incomplete block is not rare following supraclavicular brachial plexus block.[1,2] In this series 111 patients recruited for upper limb surgery during the study period and 90 patients were selected from them for brachial plexus block by supraclavicular approach. Nerve locator was used to locate the brachial plexus but incomplete or partial block was noticed in 8 cases. So failure rate is about 8.9% in this series which is comparable with other studies. [2]

The traditional method of assessing the success or failure of brachial plexus block is based on the repeated use of a painful stimulus. Sensory assessment is performed routinely for clinical purposes and plays an important role in regional anesthesia and pain research. Pinprick and cold tests used in clinical practice are particularly sensitive for detecting the effects of local anesthetics. Sensory blocks can be detected in 15-20 minutes by traditional pin pricks and hot-cold sensation tests. [5] Repeated painful stimulations are stressful and unpleasant for patient. Further success may not be predicted with confidence for a considerable time after the injection of local anesthetics. If sensation is intact, this may be unpleasant and may rapidly destroy patient confidence. Results obtained by these means are subjective and may be difficult to interpret if inconsistent, or if patient co-operation is poor. If the block fails or inadequate, further time is required to establish general anesthesia or a suitable alternative technique. Early and accurate detection of failure of peripheral nerve block enable rapid corrective action either by block supplementation or by switching to general anesthesia. This would save the operating room time and improve patient satisfactions. [3,4] Therefore an objective method to determine a successful brachial plexus block seems to be of added value.

Successful regional nerve block or plexus blocks not only produce sensory and motor block but also cause blockade of sympathetic nerve fibers. Sympathetic block produces vasodilatation and improves local perfusion. [6] Therefore local vasodilatation, increased local blood flow, and increased perfusion index can be used as a reliable tool for evaluating success or failure of regional block.

The perfusion index (PI) is the ratio of the pulsatile blood flow to the non-pulsatile or static blood in peripheral tissue such as in a fingertip, toe, or ear lobe. Peripheral Perfusion Index thus represents a noninvasive measure of peripheral perfusion that can be continuously and noninvasively obtained from a pulse oximeter. [7] Perfusion index is an indication of the pulse strength at the sensor site. The PI values range from 0.02% for very weak pulse to 20% for extremely strong pulse. Baseline perfusion index was 1.60% in this series, and similar to previous studies. [7,8]

Detection of a spike in PI is a sign to the physician for the successful onset of regional anesthesia. Conversely, no increase in PI in a patient given regional block may be an early indication of failure of block. Changes in PI are an objective indicant of anesthetic block, especially if the patients are unable to communicate their discomfort to the clinician as in mentally challenged patients.

Ginosar Y et al (2009) [4] used PI to indicate sympathectomy induced vasodilatation. PI provides an earlier and clearer indication of sympathectomy following epidural anesthesia than skin temperature and arterial pressure. [4] Alparslan Kus et al [3], investigated the reliability of PI as an objective method for assessing the adequacy of infraclavicular blockade and opined that PI index monitoring may provide a highly valuable tool to quickly evaluate the success of regional anesthesia of upper extremity in clinical practice.

Rise in perfusion index was noticed within 3 minutes following brachial plexus block and significant increase occurred at 9 minutes onwards (table 2). Mean perfusion index on non-anesthetized hand remained almost static throughout the study period. Similar observations were reported by previous workers. [9-11] Alparslan Kus et

al [3] analyzed perfusion index as an objective method for assessment of the adequacy of infraclavicular blockade and described the time course of PI changes once peripheral nerve block had been achieved. Baseline values PI ranged from 0.6% to 4.7%. There was continuous increase of PI value during 21 minutes of observation period. Though highest value of perfusion index was recorded at 21 minutes but, significant changes in PI were detected at 10 minutes after plexus block. [3] Present series also detected continuous rise in perfusion index during 21 minutes and significant rise was observed first at 9 minutes. Therefore success of block can be determined within 9 to 10 minutes.

Abdelnassar A et al [11] evaluated PI for prediction of ultra-sound guided supraclavicular block success. After deposition of local anesthetic agent, sensory block was assessed by pinprick method every 3 min and the motor block were assessed at 5 min interval by ability to flex elbow and hand against resistance. PI was observed at baseline and at 10, 20, and 30 min after injection in both blocked and non-blocked hand. They observed that the perfusion index was more in the blocked hand. The sensitivity and specificity were 100% for detection of block success by perfusion index.

Previous reports indicate high variability in PI values and ranges from 0.02% to 20% in different patients and in different scenario in same patient. [12,13] Exact value of PI to indicate success of block is difficult to determine due these variability. Abdelnassar A et al [11] proposed that PI ratio (the ratio between 10-minute PI and baseline PI) is a better predictor of successful regional block. PI ratio determines the rate of increase in PI following successful block.

Abdelnassar A et al [11] proposed a clear cut-off value for the PI and PI ratio to confirm block success. PI of 3.3 and PI ratio of 1.39 after 10 min was considered as two signs of block success. Galvin and colleagues [7] reported an increase in PI by 1.55 as a predictor of block success; this finding is near to our cut-off value for PI ratio, which is 1.4. This similarity in the cut-off value between the two studies, despite the methodological differences in the site (supraclavicular nerve block *Vs* axillary and sciatic), technique (ultrasound *Vs* nerve stimulator), and drug (bupivacaine and lidocaine *Vs* mepivacaine) would be a clue to reach a definitive cut-off value.

Mean Perfusion index ratio started increasing within 3 minutes following block and a cut-off value of 1.4 was obtained within 3 minutes in this series. However as per statistical analysis significant increase in PI ratio was observed from 9 minutes onwards and cut-off value is 2.67 which are not matching with previous reports. More studies are necessary to evaluate the role of PI ratio and its clear cut-off value for determination of success rate.

Present study indicates the perfusion index and perfusion index ratio are individual predictors of suprclavicular block by objective method. Significant changes were noticed at 9 minutes in both the parameters. More studies are warranted for precise estimation of the cut-off value of PI ratio in different nerve sites and with different local anesthetic drugs, volumes, and concentrations. Perfusion index ratio would be more accurate than using the absolute value of the perfusion index.

CONCLUSION:

Present study concludes that perfusion index is a good predictor for supraclavicular brachial plexus block success and can be used as better alternative for detection of sensory and motor loss. Perfusion index and perfusion index ratio are increased significantly in anesthetized hand and indicates that perfusion improves following plexus block. Perfusion index ratio significantly increased after 9 minutes of supraclavicular block and it is a good predictor for block success. Therefore early detection of success of block is possible by this objective method.

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