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Original Research Article

TO PREDICT THE SUCCESS OF SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK USING PULSE OXIMETER PERFUSION INDEX - A PROSPECTIVE OBSERVATIONAL STUDY

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Abstract
Background: Regional blockade at the brachial plexus provides effective and reliable anaesthesia and analgesia for upper extremity surgeries. Success is highly dependent upon the precise localization of neural structures, accurate deposition of drug around the plexus, avoiding intra-arterial injection and pneumothorax. The aim is to assess whether the perfusion index (PI) can foretell and provide cutoff value for success of supraclavicular brachial plexus block under ultrasound guidance. The objectives are to assess the predictive utility of the PI and PI ratio in relationship to efficacy of supraclavicular nerve block. **Materials and Methods:** Study design was prospective observational study. After obtaining ethics committee approval, sixty patients of age 18 to 60 years posted for elective upper limb surgeries were included in the study. With patient in supine position, supraclavicular nerve block was performed under ultrasound guidance using linear transducer. A volume of 20 ml of local anaesthetic (bupivacaine 0.5% 10 ml and lidocaine 2%, 10 ml) was injected perineurally. **Result:** There was no significant difference in baseline perfusion index between blocked and unblocked arm. Perfusion index at 10, 20 and 30 minutes was significantly high in blocked arm compared to unblocked arm. Linear increase in perfusion index was noticed in the blocked arm starting from 10 minutes to 30 minutes. With Pearson correlation test, there was a significant correlation found between perfusion index ratio and sensory block and motor block. At the cut-off value of 6.95, perfusion index at 30 minutes had sensitivity of 77% and specificity of 100% to predict sensory and motor block. At the cut-off value of 2.2, perfusion index ratio had sensitivity of 86% and specificity of 100% to predict sensory block. **Conclusion:** PI and PI ratio can be used to assess the block efficacy and in predicting block success in ultrasound guided supraclavicular block.

INTRODUCTION

Regional anaesthesia offers benefits for the patients, surgeons and anaesthesiologists because of its inherent simplicity, preservation of consciousness, avoidance of airway instrumentation, rapid recovery, prevention of undesirable effects of general anaesthetic drugs and improved postoperative analgesia.[1]
Brachial plexus block is considered to be a good alternate procedure to general anaesthesia to achieve analgesia of upper limb. Though brachial plexus block can be performed at various levels including interscalene block, supraclavicular block, infraclavicular block and axillary block. Supraclavicular approach is considered to better approach than performing brachial plexus block at

other levels because brachial plexus is more compact and superficial in this region is easy to approach.[2-4]
The major advantage of using ultrasound-guided nerve block is that it produces dense analgesia and anaesthesia with minimal dose of local anaesthetics. Onset of achieving anaesthesia and analgesia is also rapid.[5] The success of peripheral nerve block is usually assessed using neurological examination by performing sensory and motor test.[6]
However, this neurological assessment has its own limitations. Subjective nature of neurological assessment depends on patients understanding and perception. It also needs cooperation from the patients and is 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 those who are under general anaesthesia.[7,8]

A successful peripheral nerve block (PNB) would result in blockade of sympathetic nerve fibres and causes a few physiological changes including vasodilatation which leads to increase in blood flow to that area and increase in temperature.[9]

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.[10,11]

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 present study was done to identify the ability of perfusion index 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 leadings 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 the success of the block.[12]

Aim

To assess whether the perfusion index (PI) can foretell and provide cutoff value for success of supraclavicular brachial plexus block under ultrasound guidance

Primary objectives

To evaluate the PI and PI ratio as predictors of successful supraclavicular nerve block

Secondary objectives

To determine the best cutoff value for the PI in detection of block efficacy such as sensory and motor blockade.

MATERIALS AND METHODS

After obtaining institute ethics committee approval and consent, sixty patients posted for elective upper limb surgeries were included in the study. The inclusion criteria were age between 18 years and 60 years, American society of Anaesthesiologists ASA Physical status 1,2&3 and posted for elective upper limb surgery (elbow/below elbow surgery). The exclusion criteria were patient refusal, allergy to local anaesthetic drugs, peripheral vascular disease and coagulopathy

Study population underwent preanesthetic check-up with routine investigations before surgery.

The patients were kept nil per oral for six hours before surgery. Patients were monitored using minimal mandatory monitors as per institute protocol. Inj.midazolam (0.05 mg/kg) intravenously was given as premedicant in all patients.

The supraclavicular nerve block was performed under ultrasound guidance (Sonosite M Turbo) with high frequency linear transducer over the supraclavicular fossa in the coronal oblique plane immediately superior to the midclavicular point. The block was performed in the supine position with the head of the patient turned away from the side to be blocked. A 22-gauge 5 cm insulated block needle was inserted in-plane (lateral to medial) to the ultrasound probe. The brachial plexus was identified as a compact group of nerves, hypo-echoic, round or oval, located lateral and superficial to the pulsatile subclavian artery and superior to the first rib. A volume of 20 ml of local anaesthetic (bupivacaine 0.5% 10 ml and lidocaine 2%, 10 ml, distilled water 10ml) was injected perineurally under vision to surround all the neural plexus.

Perfusion index (PI)was measured in both blocked and unblocked arm at baseline, 10 minutes 20 minutes ,30 minutes. Perfusion index ratio (PIR) was calculated.

Sensory and motor block was assessed for the patients to identify the success of the block. Sensory block was assessed using 23G hypodermic blunt needle on a 3-point scale (0 -normal sensation, 1 -loss of sensation of prick [analgesia] and 2 -loss of sensation of touch [anaesthesia]) and compared to same stimulation on contralateral arm.[13] Assessment of motor block was done by modified Bromage 3 - point score (0-normal motor function with full flexion and extension of elbow, wrist and fingers, 1- decreased motor strength with ability to move fingers and/or wrist only and 2-complete motor blockade with inability to move fingers.[14]

Sample size

Sample size was calculated using open epi version using master article for PI and PI ratio at 10 minutes for a cut off 3.3 and 1.4, respectively.[15] To detect a positive correlation a sample of 60 subjects was calculated to provide 80% power.

Statistical Analysis

The collected data was entered in Microsoft Excel and transferred to SPSS software for analysis (version 22). Pearson correlation coefficient was used to analyse the association between two continuous variables. Repeated measures ANOVA was used to analyse the change in mean over time at various time intervals. Receiver operator characteristic curve was used to identify the use of perfusion index and perfusion index ratio in predicting the success of the block. For all tests of statistical significance p value of <0.05 was taken as significant.

RESULTS

Mean age of the study participants was 32.83±11.77 years which was ranging between 18 years to 60 years. Majority of the patients were aged between 18 to 30 years. [Table 1]

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Table 1: Categorization of patients based on age

Age (years)	Frequency	Percent
18 to 30 years	33	55.0
31 to 40 years	9	15.0
41 to 50 years	12	20.0
51 to 60 years	6	10.0
Total	60	100.0

72% of the patients were male and 28% of patients were female

Table 2: Perfusion index in blocked and unblocked arm

Time interval	PI in blocked arm (Mean ± SD)	PI in unblocked arm (Mean ± SD)	p-value
Baseline	2.87±.84	2.94±.88	<0.66
10 minutes	4.08±1.13	3.00±.90	<0.01**
20 minutes	7.41±2.141	2.92±.872	<0.01**
30 minutes	8.91±3.09	2.52±.91	<0.01**

** p value highly significant($p < 0.05$). SD standard deviation
Linear increase in perfusion index was noticed in the blocked arm starting from 10 minutes to 30 minutes.

Table 3: Sensitivity and specificity at different perfusion index ratio for predicting sensory block and motor block.

Perfusion index ratio	Sensitivity	Specificity
2.2	86%	100%
2.05	93%	66%
1.95	94%	33%
1.85	96%	33%

At the cut-off value of 2.2, perfusion index ratio had sensitivity of 86% and specificity of 100% to predict sensory block.

Table 4: Area under receiver operator curve (AUROC) for perfusion index at various time intervals and perfusion index for sensory block and motor block

Perfusion index	AUROC (Area under receiver operator curve)	p value
Perfusion index at 10mins	.465	.839
Perfusion index at 20mins	.731	.180
Perfusion index at 30mins	.842	.047*
PIR	.933	.012*

*p value significant, PIR perfusion index ratio
Area Under Receiver Operator Curve (AUROC) for perfusion index at 30 minutes was 0.84(0.780-0.939) (95% CI). p value <0.05 ie., 0.47 which indicates good test validity in sense of its ability to predict the sensory and motor block.
AUROC for perfusion index ratio was 0.933.
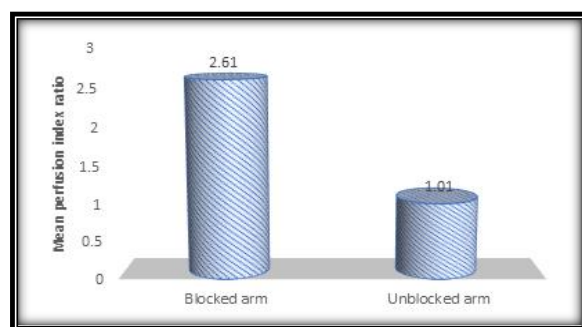
Figure 1 Bar chart depicting perfusion index ratio in blocked and unblocked arm
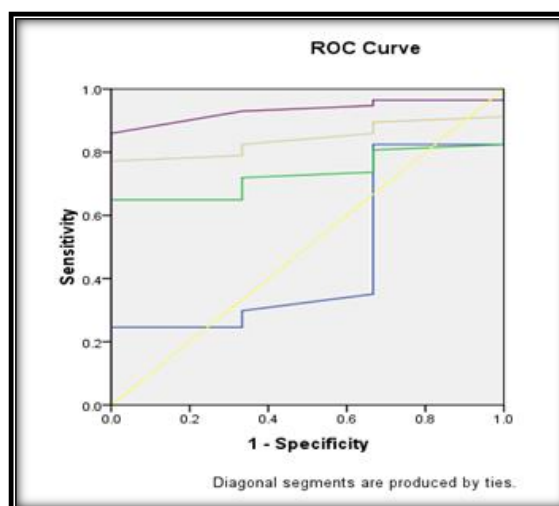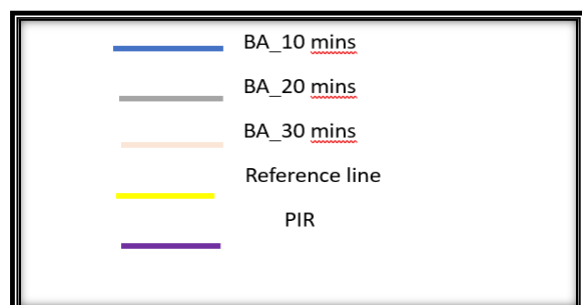
Figure 2: ROC curve to predict sensory and motor block

DISCUSSION

Pulse oximeters have known to be used for the measurement of oxygen saturation in the arterial

blood. Perfusion index (PI) measured from pulse oximeter represents a measure of peripheral perfusion that can be measured continuously and non-invasively.

Perfusion index is the ratio of the pulsatile blood flow to the non- pulsatile flow. Perfusion index ratio is considered to be a better index than perfusion index because various internal factors (elasticity of the blood vessels & intravascular volume) and external factors (variations or errors in the instruments used to measure perfusion index in the blocked and unblocked arm& adjuvant added to local anaesthetic agent) might influence the perfusion index and not the perfusion index ratio. In this study, Masimo SET pulse oximeter was used. Perfusion index ratio (PIR) is the ratio between perfusion index at 10mins and baseline perfusion index value.

Numerous factors such as elasticity of vascular wall, small peripheral vascular resistance and blood volume may affect the changes of peripheral PI. Above all peripheral vascular resistance, regulated by autonomic nervous system attribute to most to the changes of peripheral PI.

A higher PI means greater blood flow to the finger and a lower PI means lesser blood flow to the finger.[16]

In the present study, mean age of the study participants was 32.83 ± 11.77 years, almost 72% of the patients were male.

Mean heart rate at baseline was 79.2±7.4 per minute. None of the patients had bradycardia or tachycardia. Mean systolic blood pressure was 114±10.6 mmHg. Mean diastolic blood pressure was 75±7 mmHg.

In this study, [Table 2] perfusion index at 10, 20 and 30 minutes was significantly high in blocked arm compared to unblocked arm. In the present study, at all different times of measurement, perfusion index was significantly higher than the baseline value in the blocked arm. Similar findings were reported by Abdelnasser et al,[16] and Veena et al.[17]

In this study, a linear increase in perfusion index was noticed in the blocked arm starting from 10 minutes to 30 minutes. Similar to the finding of this study, another study by Avci et al also reported such linear increase in perfusion index over time.[18] Similarly, Ceylan et al reported an increase in perfusion index after 5 minutes.[19] Studies by Raj et al,[20] Sebastiani et al,[21] also found similar incremental change in perfusion index in the blocked arm.

In the current study, mean perfusion index ratio in blocked arm was 2.61 and in unblocked arm it was 1.01. The difference was statistically significant. [Figure 1] Mean perfusion index ratio in the present study was almost similar to a study by Abdelnasser et al,[16] where it was 2.5. In the study done by Veena et al,[17] also reported significantly higher mean Perfusion Index Ratio (PIR) in the blocked arm than unblocked arm.

In our study, sensory block and motor block was successful in 95% of the patients. [Table 3] Success rate of brachial plexus block in the present study was higher than the study by Lal et al,[22] where it was

92% and the study by Abdelnasser et al where it was 91%.

With Pearson correlation test, there was a significant correlation found between perfusion index ratio and sensory and motor block.

In studies focusing on PI for sensory block in supraclavicular blocks, a higher AUROC might suggest a stronger correlation between higher PI values and successful sensory block

In the present study, Area Under Receiver Operator Curve (AUROC) for perfusion index was 0.84 at 30 minutes [Table 4]. However, a study done by Kim et al reported that PI at 5 minutes served as a better predictor of Brachial plexus block.[23] AUROC for perfusion index ratio was 0.933. [Figure 2]

In the present study, at the cut-off value of 6.95, perfusion index at 30 minutes had sensitivity of 77% and specificity of 100% to predict sensory and motor block. Whereas in another study by Lal et al the best cut off for perfusion index to predict successful Brachial plexus block was 3.25.[22] [Table 3]

In the present study, at the cut-off value of 2.2, perfusion index ratio had sensitivity of 86% and specificity of 100% to predict sensory and motor block. This cut off is lower than the cut off value of 3 reported by Lal et al. In contrast to this study, Abdelnasser et al reported a very low cut off level of 1.4.[15]

The following were the limitations of our study. We didn't study the association between haemoglobin level and perfusion index ratio, and we had only few failed blocks. Failed blocks were not supplemented with rescue blocks and we did not map the nerve territory in all failed blocks.

CONCLUSION

Perfusion index potentially guide anaesthesiologists in predicting block success and optimizing their techniques. Anaesthesiologists might consider using PI values to assess the adequacy of the block and optimize dosages accordingly. Early identification of perfusion changes could lead to timely interventions Perfusion index at 30 minutes with a cut-off 6.95, perfusion index ratio with a cut off value of 2.2 would be a better predictor to predict the success of supraclavicular brachial plexus block.

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