European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 Volume 10 Issue 03 Winter, 2023

Original research article

A Prospective Observational Study To Predict Successful Supraclavicular Brachial Plexus Block Using Pulse Oximeter Perfusion Index

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ABSTRACT

Background: Upper extremity surgeries are being mostly done under regional anesthesia using supraclavicular brachial plexus block under ultrasound guidance. Subjective methods to assess the block success take time and are not very reliable.

Aims- To use perfusion index values for prediction of successful ultrasound guided supraclavicular brachial plexus block.

Materials and methods- This prospective observational study was done on 70 patients who underwent upper limb surgery. Ultrasound guided supraclavicular block was given using 20 ml of 0.5% ropivacaine in all patients. Assessment of sensory and motor block was done at every 5 minute interval. The perfusion index was noted at baseline and at 5, 10, 15, 20, 25 and 30 minutes using separate pulse oximeters on index finger of both blocked and unblocked upper limbs. The perfusion index (PI) ratio was calculated as ratio of PI at 10 minutes and PI at baseline.

Results- There was increase in perfusion index (PI) and PI ratio in the blocked arm compared with the unblocked arm with statistically significant difference.

Conclusion- Perfusion index (PI) and PI ratio at 10 min are good predictors of success of supraclavicular block which can be used non invasively in all patients.

Keywords- pulse oximetry, perfusion index, ultrasound, ropivacaine, vasodilation, brachial plexus block

INTRODUCTION

Supraclavicular brachial plexus block is widely used to facilitate surgical anaesthesia in upper limb surgeries **[1].** It can be performed either by landmark or ultrasound guided technique. Ultrasound guided brachial plexus block has evolved dramatically over the years. It helps to pass the needle toward the target nerves or facial plane and visualize the extent of local anaesthetic spread while minimizing complications [**2].** The assessment of success of peripheral nerve blocks by subjective methods including evaluation of motor and sensory functions takes time and depends on patients

input which is not always reliable [**3,4].** Sympathetic blockade results in changes in blood flow and skin temperature which can be evaluated by objective methods like thermographic temperature measurement, laser Doppler perfusion imaging and skin electrical resistance evaluation which are costly**[5]**.

Perfusion index (PI) is an easy, non-invasive objective method to evaluate the success of central neuraxial and peripheral nerve blocks **[6].** It is calculated as the ratio between pulsatile and non-pulsatile blood flow using a pulse oximeter. It is affected by changes in intravascular volume, elasticity, and intravascular pulse pressure [**7,8].** Therefore, it corresponds to changes in blood volume and varies in values depending on the dispensability of vascular walls and pulse pressure [**9].** Perfusion Index values that are evaluated in the axillary block, sciatic block and infraclavicular block have been found to be an effective method for evaluating block success [**4,10].** Perfusion index ratio is calculated as the ratio between Perfusion index (PI) at 10 minutes and baseline (PI). This has also been shown to predict block success in some studies [**7,11].**

Thus, the present research has been focused on assessing Perfusion Index and perfusion ratio for evaluation of successful ultrasound guided supraclavicular nerve block.

MATERIAL AND METHODS

The study was conducted at XXX hospital after obtaining clearance from institutional ethical committee and obtaining written informed consent from the patients. It was a prospective observational study. The study was conducted in accordance with the Helsinki Declaration of 2013. Patients who were undergoing USG guided supraclavicular brachial plexus block for upper limb surgeries under supraclavicular brachial plexus block, aged between 18-65 years , of either sex, ASA physical status I or II were included in this study. The patients who refused to participate in the study, with allergy to local anaesthetic agents, infection at the local site of needle insertion or cardiovascular or cerebrovascular disease or peripheral vascular disease, coagulopathy and patients with history of epilepsy were excluded from study. Seven patients with failed block were excluded from the study.

All patients were subjected to a detailed history, thorough physical examination and systemic examination prior to the surgery. Basic demographic data including age, height and weight were recorded. Routine investigations such as complete blood count, blood sugar, renal function test, liver function test, blood grouping, cross matching, bleeding time, clotting time, electrocardiography (ECG) or any specific tests if indicated were done . Patients were explained in detail about the anaesthesia procedure. Informed consent was taken and pre-operative fasting for 8 hours was ensured.

In the operation theatre, standard monitoring was instituted. Baseline parameters including Non-invasive blood pressure, heart rate (HR), oxygen saturation (Spo2), respiratory rate (RR) and electrocardiogram (ECG) were attached. An intravenous 18G/20G cannula was secured in the non operating limb of the patient. The baseline perfusion index (PI) was noted in the supine position using two separate pulse oximeters applied to the left index and right index finger to measure the perfusion index in both the blocked and unblocked limbs.

The supraclavicular nerve block was performed using ultrasound guidance with linear transducer (8– 14MHz; SONOSITE M TURBO) over the supraclavicular fossa in the coronal oblique plane immediately superior to the mid-clavicular point. The block was given in the supine position under all aseptic precautions, with the head of the patient turned away from the side to be blocked. 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 22-gauge insulated block needle was inserted in-plane (lateral to medial) to the ultrasound probe. A volume of 20 ml of Ropivacaine 0.5% was injected under vision.

In all patients skin temperature was measured on both hands. Same surrounding environment and supine position was maintained during the study period to prevent changes in Perfusion Index due to external factors.

After the completion of local anesthetic injection, the limb evaluated at every 5 min for the sensory and motor block until 30 minutes after injection. The sensory block was evaluated in the distributions of the radial, median, ulnar and musculo-cutaneous nerve dermatomes with the pinprick test using a blunt-tip needle. The motor block was tested according to the capacity to flex the elbow and hand against gravity. The block was considered successful when brachial plexus dermatomes (C5–T1) were completely blocked.

Partial block was defined when a sensory region involved in the surgery was not completely anesthetized and the block was supplemented with fentanyl 2mcg/kg. If the patient still experienced pain despite supplementation and required general anaesthesia for surgery, it was considered block failure. Any patient requiring general anesthesia due to partial or failed block were excluded from the study.

The Perfusion Index was recorded at following time points: at baseline and then every 5 minutes for 30 minutes. The PI ratio was calculated as the Perfusion Index at 10 minutes divided by that at the baseline. This was recorded and compared in both and unblocked limbs. Patients were monitored for hemodynamic parameters at regular intervals throughout the surgery.

STATISTICAL ANALYSIS

Based on the study by Abdelnasser A et al**[7]** a sample size of atleast 70 patients was calculated assuming 95% confidence interval to obtain a study power of 80% and alpha error of 0.05. The Statistical Software IBM SPSS Statistics version 22 and Microsoft Excel 2007 were used for the analysis of the data. Categorical data was presented as frequency while continuous data was presented as mean and standard deviation. The data obtained was subjected to statistical analysis using paired student t test. The value of $p < 0.05$ was considered statistically significant and p value < 0.001 as highly significant.

RESULTS:

We enrolled 77 patients in our study out of which 7 were excluded due to failure of block. Seventy patients were finally analysed for statistical interpretation. The baseline parameters and demographical variables were as shown in Table 1.

Table 1 – Demographic variables in patients.

Characteristic	Value (Mean ± SD)
Age(in years)	38.1±14.58
Gender (male /female)	56 /14
Duration of surgery(in hours)	1.84±0.36
ASA grade (I/ II)	44/26

SD- Standard Deviation, ASA- American Society of Anesthesiology

The perfusion index was comparable in both blocked and unblocked arms at baseline as shown in figure 1. The perfusion index increased in the blocked arm after 5 minutes of injecting ropivacaine compared to the baseline as well as compared to unblocked arm. The increase in PI in blocked arm at 5, 10, 15, 25 and 30 minutes remained highly significant. There was no increase in PI seen in the unblocked limb at these intervals as shown in figure 1.

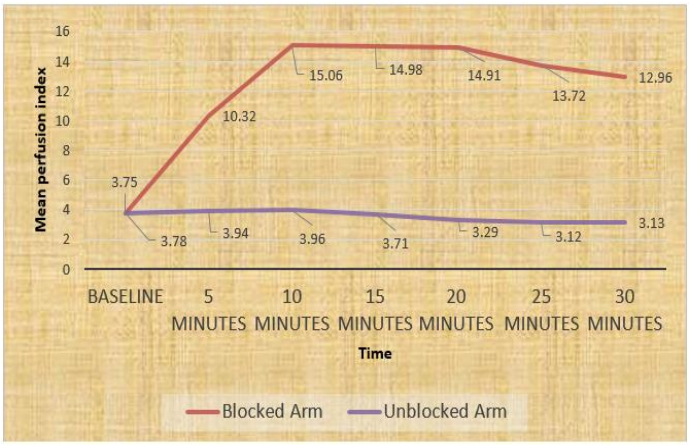

Figure 1- Comparison of Perfusion Index Between Blocked Arm and Unblocked Arm

The PI ratio calculated as ratio of PI at 10 minutes and at baseline was 4.10 ± 0.66 in the blocked limb and 1.06±0.13 in the unblocked limb. This difference was highly significant (p value <0.01).

DISCUSSION

Sympathetic blockade after peripheral nerve block results in dilatation of blood vessels in the territory of block [5]. The assessment of success of block have been evaluated using a variety of methods in the past. Sensory and motor function assessments are subjective methods which are time consuming and not always reliable**[12]**. Measurement of skin temperature, Doppler perfusion imaging, non invasive blood haemoglobin assessment are various objective methods used but they require expensive equipment**[4,5,13]**. Perfusion index (PI) is the ratio between pulsatile and non pulsatile blood flow. It is automatically calculated by a pulse oximeter non invasively. As there is a relative increase in blood flow after a successful block due to sympathectomy, this leads to an increase in PI **[6]**. Our study was done to evaluate the role of PI in prediction of successful supraclavicular brachial plexus block. PI values can vary depending on the adjuvants added to the local anesthetic for the block affecting the condition of blood vessels **[14]**. We did not use any adjuvant along with ropivacaine in our study. Previous studies have reported increase in PI in conditions where vasodilation occurred like after induction of anesthesia **[15]**.

In our study, PI increased after 5 minutes of local anesthetic injection for supraclavicular block in the blocked arm and the values remained high upto 30 minute after the block. There was no increase in PI in the unblocked arm. The increase in the PI indicated changes in blood flow due to sympatholytic effect of successful brachial plexus block. There was statistically significant increase in PI from baseline in the blocked arm ($p<0.05$). Ginosar et al**[16]** showed that PI is a more sensitive predictor of epidural induced sympathectomy than skin temperature or arterial blood pressure. Yamazaki et al showed positive association between changes in perfusion index and efficacy of stellate ganglion block**[17]**.

In our study, PI ratio calculated as ratio of PI at 10 minutes and PI at baseline was significantly higher in the blocked arm (4.10±0.66) compared to the unblocked arm (1.06±0.13). The PI ratio is a more significant predictor of successful peripheral nerve block as this shows the rate of increase in PI in a successful block**[6]**. Hasnain et al**[18]** also reported the changes in PI as a more reliable indicator of pain assessment in critically ill patient compared to absolute PI values. Our study results are comparable to those by Abdelnasser et al **[6]** which showed that PI index ratio at 10 minute have a sensitivity and specificity of 100 percent for block success. Lal et al **[9]** and Veena et al **[10]** had also showed that there was significant difference in PI of blocked arm and unblocked arm from baseline to 30min in their studies. Kus et al **[6]** showed that largest changes in the PI occurred 30 minute after giving local anesthetic drug for infraclavicular block but significant changes could be detected at 10 minutes after the block. In our study, in the blocked limbs at 5 min

after local anesthetic injection, mean PI was 10.32±1.71 and mean baseline PI was 3.75±0.61 compared to that of unblocked limbs, where the mean PI at 5 min was 3.94±0.54 and baseline PI was 3.78±0.54 .Thus we could detect a significant change in PI as early as 5 minutes after the block with p value <0.05.

PI is a marker of peripheral perfusion automatically calculated by pulse oximeter and thus an effective, easy, inexpensive objective tool to predict the success of supraclavicular brachial plexus block. This allows timely prediction of adequacy of peripheral nerve block. PI ratio is more accurate predictor than the absolute values of PI due to variability in the baseline PI values seen in the population.

The limitations of our study was that there was no blinding allowed in our study, so the detection and performance bias may exist, leading to overestimated outcome measures. Also our follow up period was limited to 30 minutes only which could have limited us to assess the delayed variations in PI values. Future studies are warranted to get a clear cut off value of PI and PI ratio in cases with failed and partial blockade which were excluded from our study due to low number of cases for comparison.

CONCLUSION

Perfusion index and perfusion index ratio are useful to quickly predict success of supraclavicular brachial plexus block without requiring sophisticated equipment.

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