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Original research article

PULSE OXIMETER PERFUSION INDEX AS A PREDICTOR OF SUCCESSFUL SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK

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Abstract

Background: Supraclavicular brachial plexus block under ultrasound guidance is the most commonly used technique to provide anaesthesia for upper limb surgeries. Routine methods used for evaluation of block success needpatient co-operation and are time consuming. A successful supraclavicular nerve block is associated with vascular dilation. Perfusion index, which is automatically calculated by pulse oximetry, provides an indication of peripheral perfusion at sensor site.

Aim: The aim of study is to assess perfusion indexas a predictor of successful supraclavicular brachial plexus block. The objective of the study is to assess whether PI and PI ratio can be used as an alternative for sensory or motor function tests to assess success of supraclavicular block.

Material and Methods: This is a prospective observational study conducted at kamineni institute of medical sciences, Narketpally from March 2023-October 2023. After obtaining informed written consent, total of 60 patients, aged between 20-60 years belonging to ASA physical status 1 and 2, undergoing upper limb surgeries (forearm surgeries) under ultra-sound guided supraclavicular brachial plexus block were included. After local anaesthetic injection, sensory and motor block were assessed every 5 minutes till 20 minutes. Perfusion index (PI) was recorded at baseline and every 5 minutes till 20 minutes after block in both blocked and unblocked upper limb simultaneously. PI ratio calculated as PI at 10 minutes divided by PI at baseline.

Results: Perfusion index was higher in blocked limb at all time points compared to baseline and to unblocked limb. Both PI and PI ratio were found statistically significant.

Conclusion: PI and PI ratio can be used as an alternative tool to assess the success of supraclavicular brachial plexus block.

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Keywords: PI (perfusion index), supraclavicular brachial plexus block, ultra-sound

Introduction

Regional anaesthesia is beneficial to patients, surgeons and anaesthesiologists because of its simplicity, preserved consciousness, avoidance of general anaesthesia and airway instrumentation, norecovery problems and better postoperative analgesia [1]. Ultrasound guided supraclavicular brachial plexus block is a popular choice for anaesthesia for upper limb surgeries [2]. It provides a better understanding of neural structures and guides the needle towards nerve plexus.

Routinely the success of nerve block is assessed by evaluating the sensory and motor function. Traditional way of assessing block success is pin prick, which is subjective, time consuming, painful and requires patient cooperation. 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 includesskin temperature measurement, monitoring skin electrical resistance, tissue oxygen saturation. But they either require special equipmentor are time consuming. Limited data available on PI (perfusion index) which is a simple, non-invasive and easy method (automatically calculated by pulse oximetry) 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.

Materials and Methods

This is a prospective observational study conducted at Kamineni institute of medical sciences, Narketpally from March 2023-October 2023. After obtaining Institutional and Ethics committee approval and informed written consent, total of 60 patients (power 80%) of age 20-60 years belonging to ASA physical status 1 and 2 undergoing upper limb (forearm) surgeries under ultra-sound guided supraclavicular brachial plexus block were included. Patients with bleeding disorders, with cardiovascular and cerebrovascular disorders, with partial or failed block or which converted to general anaesthesia were excluded from the study. All patients were subjected to detailed history, thorough physical and systemic examination before surgery. Basic demographic data was noted. Routine investigations were done. Baseline PI was noted in supine position using two separate pulse oximeters. Supraclavicular brachial plexus block was performed using ultra-sound guidance with linear probe. Under all aseptic precautions, with patient head turned to opposite side, block was performed in supine position by using 22-gauge insulated block needle, inserted via in-plane approach. Brachial plexus was identified as compact group of hypo-echoic, round structures seen lateral to subclavian artery. Afterlocal anaesthetic injection-10 ml of 0.5% Bupivacaine with 10ml of 2% lignocaine with adrenaline under ASA standard monitoring, under standard operating room conditions, sensory and motor block were assessed every 5

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minutes till 20 minutes. Sensory block assessed by pinprick test using blunt tip needle. Motor block assessed by ability to flex forearm against gravity. The block was considered successful when brachial plexus dermatomes were completely blocked. Perfusion index (PI) was recorded at baseline and every 5 minutes till 20 minutes after block in both blocked and unblocked upper limb simultaneously with the help of pulse oximeters applied on index fingers. In every patient PI was compared between blocked and unblocked limb. Piratio was calculated as PI at 10 minutes divided by PI at baseline.

Statistical Analysis

The collected data was entered in Microsoft Excel and transferred to SPSS software for analysis (version 25). 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 considered to be statistically significant.

Results

Table 1: Demographic Characteristics

Characteristics	Values (Mean ±SD)
Age (years)	37.98 ± 9.073
Gender (M/F)	45/15

60 patients were included in the study. Out of which, 45 were males and 15 were females. Average age was 37.98 ± 9.07.

Table 2: Perfusion index in blocked and unblocked limb

Time Interval (in min)	PI in blocked arm (Mean ± SD)	PI in unblocked arm (Mean ± SD)	*p*-value
Baseline	2.465 ± 0.6535	2.518 ± 0.6398	
5	3.745 ± 0.7606	2.530 ± 0.6505	<0.001
10	6.052 ± 1.4666	2.530 ± 0.6505	<0.001
15	9.732 ± 1.9516	2.530 ± 0.6505	<0.001
20	12.580 ± 2.3782	2.530 ± 0.6505	<0.001

P value highly significant (p<0.05). SD-standard deviation.

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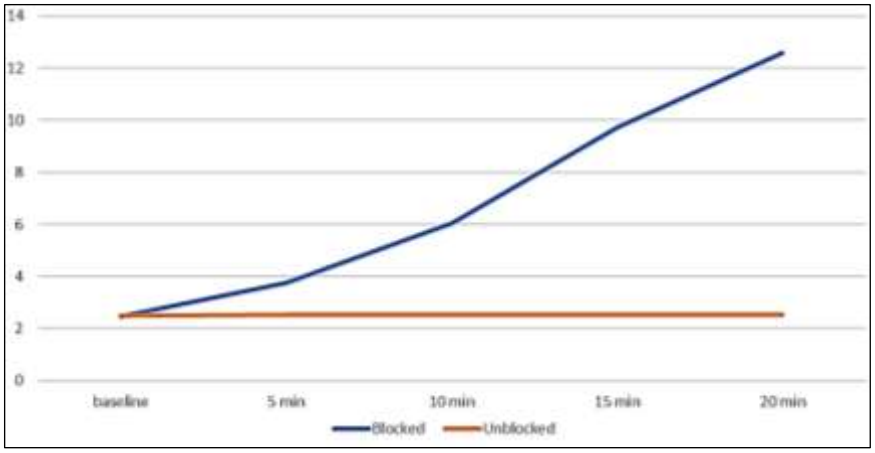

Fig 1: Trend of PI in blocked and unblocked limb over time

The PI was comparable in both blocked and unblocked arms at baseline as shown in figure. The PI increased in blocked arm after 5 minutes of block compared to both baseline and to unblocked arm. The increase in PI in blocked arm at 5,10,15,20 minutes remained highly significant. There was no increase in PI seen in the unblocked arm at these intervals as shown in figure.

Table 3: PI Ratio in blocked and unblocked limb

	Blocked	**Unblocked**	***p*-value**
PI Ratio	2.6386 ± 0.987	1.0041 ± 0.016	<0.001

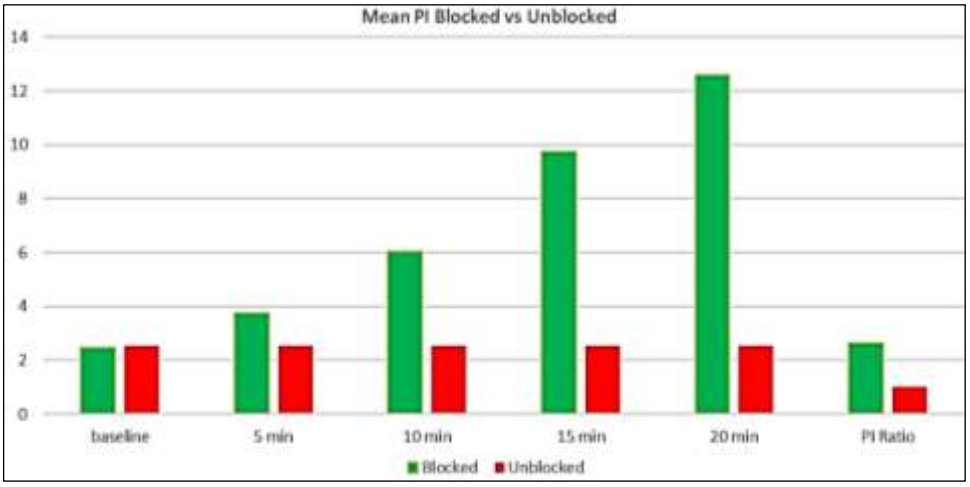

Fig 2: Mean PI values in Blocked and Unblocked limbs at intervals and PI Ratio. The PI ratio calculated as ratio of PI at 10 minutes and at baseline was 2.63 ± 0.98 in blocked arm and 1.00 ± 0.01 in unblockedarm. The difference was highly significant (p value < 0.001)

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Table 4: Comparison with various studies

Mean	PI at 10 Min Blocked Arm	PI at 10 Min Unblocked Arm	PI Ratio Blocked Arm	PI Ratio Unblocked Arm
Abdelnasser *et al*.	6.9 ± 1.7	2.8 ± 0.8	2.5 ± 0.4	1 ± 0.1
Loretta *et al*.	1.45 ± 0.65	1.21± 0.48	7.56 ±3.32	1.3 ± 0.67
Veena *et al*.	7.46 ± 1.10	2.10 ±1.03	3.70 ± 1.07	1.04 ± 1.00
Narsimhan *et al*.	4.08 ± 1.13	3.00 ± 0.90		
Our Study	6.052 ± 1.4666	2.530± 0.6505	2.6386 ±0.987	1.0041± 0.016

Discussion

Sympathetic blockade after peripheral nerve block results in dilatation of blood vessels in the territory of block [3]. The assessment of success of block have been evaluated using a variety of methods in the past. Sensory (pinprick) and motor function assessments are subjective methods which are time consuming and not always reliable [4]. Measurement of skin temperature, Doppler perfusion imaging, non-invasive blood haemoglobin assessment are various objective methods used but they require expensive equipment [5, 6]. 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 sympathetic blockade, this leads to an increase in PI [7]. Our study was done to evaluate the role of PI in prediction of successful supraclavicular brachial plexus block. Previous studies have reported increase in PI in conditions where vasodilation occurred like after induction of anaesthesia [8].

In our study, PI increased after 5 minutes of local anaesthetic injection for supraclavicular block in the blocked arm and the values remained high upto 20 minutes 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*. [9] 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 [10].

In our study, PI ratio calculated as ratio of PI at 10 minutes and PI at baseline was significantly higher in the blocked arm (2.6386 ± 0.987) compared to the unblocked arm (1.0041 ± 0.016). 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. Hasnain *et al*. [11] also reported the changes in PI ratio 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*. [12] which showed that PI index ratio at 10minutes have a sensitivity and specificity of 100 percent for block success. Lal *et al*. [13] and Veena *et al*. [14] 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*. [7] showed that largest changes in the PI occurred 30 minutes after giving local anaesthetic 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

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anaesthetic injection, mean PI was 3.745 ± 0.7606 and mean baseline PI was 2.465 ± 0.6535compared to that of unblocked limbs, where the mean PI at 5 min was 2.530 ± 0.6505 and baseline PI was 2.518 ± 0.6398. As a result, 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 were that there was no blinding in our study, so the detection and performance bias may exist, leading to overestimated outcome and also our follow up period was limited to 20 minutes only which could have limited us to assess the delayed variations in PI values.

Conclusion

PI and PI ratio potentially guides anaesthesiologists in predicting block success and optimizing their techniques without help of special equipment. 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. Thus, PI and PI ratio can be uses as alternative tool to predict successful supraclavicular brachial plexus block.

Conflict of Interest: None.

Funding Support: Nil.

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