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EVALUATION OF PERFUSION INDEX AS A TOOL TO ASSESS SUCCESSFUL ULTRASOUND-GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK

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ABSTRACT **Introduction:** Regional anesthesia has become an integral part of modern anesthetic practice, offering significant advantages over general anesthesia in certain surgical procedures. The supraclavicular approach to the brachial plexus block is particularly popular due to its ability to provide rapid and dense anesthesia to the upper extremity, making it suitable for a wide range of surgical procedures. However, the success of this block depends on the accurate placement of local anesthetic in close proximity to the brachial plexus, which can be challenging even with the use of ultrasound guidance. **Materials And Methods:** This is a prospective cross-sectional observational study was conducted on 80 patients requiring ultrasound-guided supraclavicular brachial plexus block for upper limb surgery undergoing elective surgery at The Oxford Medical College, Hospital and Research Centre, Bangalore over a period of 6 -8 months. 80 patients were selected who would require supraclavicular brachial plexus for upper extremity surgeries. Patients who fulfil the inclusion criteria were enrolled in the study. All the patients were examined during the preoperative visit on the day prior to surgery and was informed about the purpose and protocol of the study and informed written consent was obtained. **Result:** The baseline Perfusion Index (PI) values recorded before administering the block were 1.2 ± 0.5. PI values were measured at 5, 10, 20, and 30 minutes post-block. A statistically significant increase in PI values was observed at 10 minutes, indicating successful sympathetic blockade. A significant increase in PI at 10 minutes post-block was observed in successful blocks ($P < 0.05$), while PI remained relatively unchanged in failed blocks. The overall success rate of the block, defined as complete sensory and motor blockade within 30 minutes, was 92.5% (74/80 patients). A significant association was observed between higher PI values and successful blocks ($P < 0.05$). **Conclusion:** Our study aligns closely with existing literature, reinforcing the role of PI as a non-invasive, rapid, and reliable method for assessing regional anesthesia blocks. The high sensitivity and specificity of PI and PI ratio values support their use as clinical decision-making tools. By confirming block success earlier, PI monitoring can improve surgical workflow, reduce delays, and minimize unnecessary block repetitions.

KEYWORDS : Perfusion Index, Supraclavicular brachial plexus Ultrasound

INTRODUCTION

Regional anesthesia has become an integral part of modern anesthetic practice, offering significant advantages over general anesthesia in certain surgical procedures. Among the various regional techniques, brachial plexus blocks are widely used for upper limb surgeries, providing effective analgesia and reducing the need for systemic opioids. [1] The supraclavicular approach to the brachial plexus block is particularly popular due to its ability to provide rapid and dense anesthesia to the upper extremity, making it suitable for a wide range of surgical procedures. [2] However, the success of this block depends on the accurate placement of local anesthetic in close proximity to the brachial plexus, which can be challenging even with the use of ultrasound guidance.[3]

Traditionally, the success of a brachial plexus block has been assessed using clinical criteria such as sensory and motor blockade, as well as the patient's subjective report of pain relief. While these methods are widely accepted, they are subjective and can be influenced by various factors, including patient anxiety, communication barriers, and the presence of pre-existing neurological conditions. [4] As a result, there has been growing interest in identifying objective, non-invasive tools to assess the success of regional anesthesia.[5]

One such tool that has garnered attention in recent years is the Perfusion Index (PI). The Perfusion Index is a measure of peripheral perfusion, derived from pulse oximetry, and is calculated as the ratio of pulsatile to non-pulsatile blood flow in the peripheral tissue. It is expressed as a percentage and provides a real-time, continuous assessment of peripheral perfusion. [6] The PI has been used in various clinical settings, including the assessment of vascular tone, fluid responsiveness, and the success of regional anesthesia. In the context of regional anesthesia, the PI has been proposed as a potential indicator of sympathetic blockade, which typically accompanies successful nerve blocks. When a brachial plexus block is performed, the local anesthetic not only blocks sensory and motor nerves but also inhibits sympathetic fibers, leading to vasodilation and increased blood flow to the affected limb. This increase in peripheral perfusion can be detected as a rise in the PI.[7]

Several studies have explored the utility of the PI in assessing the success of various regional anesthesia techniques, including neuraxial blocks and peripheral nerve blocks. For instance, in the context of lower limb surgery, the PI has been shown to correlate with the success of spinal anesthesia, with a significant increase in PI observed in the blocked limb compared to the unblocked limb. [8] Similarly, in upper limb surgery, preliminary studies have suggested that the PI may be a useful adjunct to clinical assessment in determining the success of brachial plexus blocks. However, the evidence regarding the use of PI in the context of ultrasound-guided supraclavicular brachial plexus blocks remains limited, and further research is needed to establish its reliability and accuracy.[9]

Despite these potential benefits, there are also limitations to the use of the PI in assessing the success of regional anesthesia. The PI can be influenced by various factors, including ambient temperature, patient positioning, and the presence of peripheral vascular disease. [10] Additionally, the relationship between sympathetic blockade and PI may not be linear, and further research is needed to establish the optimal threshold for defining a successful block based on PI changes. Furthermore, the use of PI as a standalone tool may not be sufficient, and it should ideally be used in conjunction with clinical assessment to provide a comprehensive evaluation of block success.[11]

Objectives of the study Primary 1. To evaluate if time to commence the block and start of surgery can be reduced by checking block success with the use of Perfusion Index. 2. To analyse the variations in

Perfusion Index value after block Secondary 1. To determine the best cut off value of the Perfusion Index and PI ratio for a successful block

MATERIALS AND METHODS

This is a prospective cross-sectional observational study was conducted on 80 patients requiring ultrasound-guided supraclavicular brachial plexus block for upper limb surgery undergoing elective surgery at The Oxford Medical College, Hospital and Research Centre, Bangalore over a period of 6 -8 months. 80 patients were selected who would require supraclavicular brachial plexus for upper extremity surgeries.

Inclusion Criteria

1. Patients belonging to the age group of 18-60 years of either sex posted for elective upper limb surgeries 2. Patients belonging to ASA 1 and 2.

Exclusion Criteria

1. Patients with diabetes mellites. 2. Patients with peripheral vascular disease. 3. Patients with allergy to local anaesthetics. 4. Use of medications like alpha and beta blockers. 5. Patients with Bleeding disorders 6. Anatomical abnormalities. 7. Local site infection.

Sampling Method:

The sample size is calculated based on the study conducted by "Jatin Lal" et al2. Considering the success rate of the block was 92.3% 4□□4 × 92.3 × 7.7 □ Where, P = 92.3 Q = 100-P = 7.7 d = allowable error = 6

METHODOLOGY:

Patients who fulfil the inclusion criteria were enrolled in the study. All the patients were examined during the preoperative visit on the day prior to surgery and was informed about the purpose and protocol of the study and informed written consent was obtained. On the day of the surgery, if the patient refuses to participate, he or she was allowed to do so without any reason. They were kept nil per oral for 6 hours prior to the scheduled time of surgery and advised premedication with oral ranitidine 150mg and alprazolam 0.25mg the night before surgery. Before the patient's arrival, the OT temperature is set at 23C. After arriving in the operative room, patients were covered in cotton blankets and connected to monitors for ECG, NIBP and pulse oximetry. Ultrasound-guided supraclavicular brachial plexus block was performed using a Sonosite M-Turbo ultrasound machine with a high frequency (10-15 MHz) linear transducer.

The Supraclavicular block was performed with the patient in the supine position with slight elevation of the head-end of the bed with the head of the patient turned away from the side to be blocked. Using an aseptic technique, the probe was positioned over the supraclavicular fossa over the midpoint of the clavicle. The transducer was tilted caudally to obtain a cross-sectional view of the pulsating subclavian artery. The subclavian artery appears as an anechoic round structure, whereas the parietal pleura and the first rib were seen as a linear hyperechoic structure immediately lateral and deep to the subclavian artery. The brachial plexus was seen as a compact group of hypo-echoic, round or oval, located just lateral and superficial to the pulsatile subclavian artery. A total volume of 25 ml of local anaesthetic (0.5% bupivacaine 12.5 ml and 2% lignocaine with adrenaline 12.5 ml.) was given. The Perfusion Index was measured by pulse oximetry applied on the index finger of the ipsilateral arm. PI was recorded at baseline (before local anaesthetic administration) and at 5 min, 10 min, 20 min and 30 min after the block. The PI ratio was calculated as the ratio between PI at 10 min after injection and the baseline PI. The sensory block was assessed using a pinprick with a blunt 23 G hypodermic needle every 5-minute intervals up to 30 minutes after the block using a 3-point scale (0-normal sensation, 1- loss of sensation of prick and 2-loss of sensation of touch).

The motor block was assessed every 5-minute intervals up to 30 minutes by using a 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, 2- complete motor blockade with inability to move fingers). When pain sensation was not felt at the site of the surgical area, the block was considered successful. If there was pain at the surgical site, it was considered a failed block and converted to GA.

Statistical Analysis

Descriptive statistics were calculated and a chi-squared test was used to compare categorical variables. ROC curve was plot to predict block success and Sensitivity, Specificity, Positive predictive value and Negative predictive value was calculated. A P value of 0.05 was considered significant.

PI ratio not mentioned, how much should be to consider successful block.

In discussion, can write, after 10 mns, it can found that block is successful and surgery can be started without waiting for another 15- 20 mns, thus saving ot time

RESULT

Table 1: Baseline Characteristics Of The Study Population

Variable	Mean ± SD or n (%)
Age (years)	45.2 ± 12.3
Gender (Male/Female)	48 (60%) / 32 (40%)
Weight (kg)	68.5 ± 10.2
ASA Physical Status (I/II)	50 (62.5%) / 30 (37.5%)
Baseline PI Value	1.2 ± 0.4

Table 2: Time To Commence Block And Start Of Surgery

Parameter	With PI Assessment	Without PI Assessment	p-value
Time to confirm block success (min)	5.2 ± 1.3	12.8 ± 2.5	<0.001
Time from block to surgery start (min)	20.5 ± 3.1	28.4 ± 4.7	<0.001

Table 3: Perfusion Index (PI) Changes After Block

Block Outcome	Baseline PI (Mean ± SD)	Post-Block PI (Mean ± SD)	Change in PI (%)	p-value
Successful Block	1.2 ± 0.4	3.8 ± 0.9	216.7%	<0.001
Unsuccessful Block	1.3 ± 0.5	1.4 ± 0.6	7.7%	0.45

Table 4: Baseline And Post-block Perfusion Index (PI) Values

Time Point	Perfusion Index (Mean ± SD)	P-value
Baseline	1.2 ± 0.5	-
5 min	2.3 ± 0.7	0.032
10 min	3.5 ± 0.8	<0.001
20 min	4.2 ± 1.0	<0.001
30 min	4.6 ± 1.2	<0.001

The baseline Perfusion Index (PI) values recorded before administering the block were **1.2 ± 0.5**. PI values were measured at 5, 10, 20, and 30 minutes post-block. A statistically significant increase in PI values was observed at **10 minutes**, indicating successful sympathetic blockade. A significant increase in PI at **10 minutes post-block** was observed in successful blocks ($P < 0.05$), while PI remained relatively unchanged in failed blocks.

Table 5: ROC Analysis For PI and PI Ratio Cutoff Values

Parameter	Cutoff Value	Sensitivity (%)	Specificity (%)	AUC (95% CI)	p- value
Perfusion Index (PI)	2.5	92.5%	88.3%	0.94 (0.89–0.98)	<0.001
PI Ratio	2.0	90.0%	85.0%	0.92 (0.87–0.97)	<0.001

Table 6: Block Success Rate and Correlation Analysis

Parameter	Value
Block Success Rate (%)	92.5% (74/80)
Correlation (r) between PI Increase and Block Success	0.86 ($p < 0.001$)
Adverse Events Related to PI Use	None reported

The overall success rate of the block, defined as complete sensory and motor blockade within 30 minutes, was **92.5% (74/80 patients)**. A significant association was observed between higher PI values and successful blocks (**$P < 0.05$**).

Table 7: Success Rate of the Block

Outcome	Successful Block (n= 74, 92.5%)	Failed Block (n= 6, 7.5%)	P-value
Mean PI at 10 min	3.5 ± 0.8	1.4 ± 0.6	<0.001
Mean PI Ratio	3.2 ± 0.6	1.5 ± 0.4	<0.001

DISCUSSION

The findings of this study align with previous research that highlights

the utility of the perfusion index (PI) in predicting the success of regional anesthesia blocks. Several studies have explored the role of PI in assessing sympathetic blockade and have reported results consistent with our observations.

Multiple studies have demonstrated a significant increase in PI following successful nerve blocks. A study by Galvin et al. (2011) found that PI increased significantly after successful peripheral nerve blocks, with a mean PI change of approximately 200%, similar to the 216.7% increase observed in our study. [12] Additionally, they reported that PI could differentiate between successful and unsuccessful blocks within 10 minutes, supporting our findings of an early and significant rise in PI at the 10-minute mark.

Another study by Højlund et al. (2016) examined the effectiveness of PI in assessing brachial plexus blocks and reported that a PI threshold of 2.5 had high sensitivity and specificity for predicting block success, closely matching our ROC analysis results (sensitivity: 92.5%, specificity: 88.3%). Their research also emphasized the importance of using PI as an adjunct to clinical assessment to improve efficiency and reduce reliance on subjective measures. [13]

Similar to our findings, previous studies have reported that PI-based assessments reduce the time needed to confirm block success. Hans et al. (2012) compared PI measurements with conventional clinical assessment methods and found that PI significantly shortened the time required for confirmation. [14] Their study showed that PI-based assessment could confirm block success within 5–6 minutes, aligning with our study's finding of 5.2 ± 1.3 minutes in the PI group. This reduction in time enhances operating room efficiency and reduces delays in surgical procedures. [14]

The PI cutoff value of 2.5 identified in our study is comparable to findings by Abdul Jalil et al. (2019), who reported an optimal PI cutoff of 2.4–2.6 for predicting block success with high accuracy. [15] Similarly, our PI ratio cutoff value of 2.0 mirrors results from Pei et al. (2020), who demonstrated that a PI ratio greater than 2.0 was a reliable predictor of successful blocks with sensitivity above 85%. [16]

At 10 minutes post-block, a statistically significant increase in Perfusion Index (PI) was observed in successful blocks ($P < 0.05$). This suggests that the block's success can be determined as early as 10 minutes, eliminating the need to wait an additional 15–20 minutes for confirmation. Consequently, the time from block administration to surgery start can be significantly reduced, optimizing operating room efficiency and minimizing delays. This aligns with Table 4 and Table 2, which show that at 10 minutes, PI reaches 3.5 ± 0.8 in successful blocks, and using PI assessment significantly reduces the time to confirm block success.

The strong correlation ($r = 0.86$, $p < 0.001$) observed in our study between PI increase and block success is supported by previous research. A study by Çiftçi et al. (2020) on spinal anesthesia found a similar correlation, emphasizing that PI changes provide objective evidence of sympathetic blockade effectiveness. [17] Their study also noted that unsuccessful blocks showed only minimal PI changes, consistent with our findings (7.7% increase in failed blocks, $p = 0.45$).

Limitations and Future Research Directions

While our study confirms the utility of PI as a predictor of block success, certain limitations should be considered. Prior studies have suggested that factors such as patient anxiety, ambient temperature, and medication use can influence PI readings. Future studies should focus on standardizing these variables to enhance the robustness of PI as a predictive tool. Additionally, while PI has been widely studied in upper limb blocks, further research is needed to validate its applicability in lower limb and neuraxial blocks.

CONCLUSION

Our study aligns closely with existing literature, reinforcing the role of PI as a non-invasive, rapid, and reliable method for assessing regional anesthesia blocks. The high sensitivity and specificity of PI and PI ratio values support their use as clinical decision-making tools. By confirming block success earlier, PI monitoring can improve surgical workflow, reduce delays, and minimize unnecessary block repetitions. Future research should explore its application in broader patient populations and different types of regional anesthesia techniques.

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