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Original research article

A Comparative Study Using Perfusion Index to Assess the Adequacy of Supraclavicular Brachial Plexus Block Between Conventional and Ultrasound-Guided Technique

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Abstract

Background: Brachial plexus blocking is a tested technique for performing upper limb procedures. The traditional approach employing the paresthesia technique is a blind technique that may be associated with a greater failure rate and nerve and surrounding structural harm. Perfusion index (PI) is a new simple, objective, and non-invasive method for the evaluation of the success of central neuraxial and peripheral nerve blocks.

Methods: A total of n=60 cases were included in the study following the inclusion and exclusion criteria. They were randomly allotted into two *Group C (Conventional)* n=30 receive Conventional Supraclavicular brachial plexus block Landmark guided. *Group U (Ultrasound-guided)* n=30 To receive Ultrasound-guided Supraclavicular brachial plexus block. Patients will be subjected to pre-anesthetic evaluation. Routine monitors will be connected (ECG, Automated NIBP, pulse oximeter).

Results: The mean value of perfusion index of the blocked limb in the USG group came to be 12.6 and the mean value of perfusion index of the blocked limb in the conventional Group came out to be 10.6, whereas that of the unblocked limb remained constant. The values were significant for the perfusion index of the blocked limb. In both groups, serial increases in perfusion index values were observed after successful blocks. In the Ultrasound group, the perfusion index value at 30 minutes increased to 12.6 from the baseline value of 3.13 while in the conventional group the value observed at 30 minutes was 10.7 in comparison to the baseline value of 2.47 the p values were significant.

Conclusion: The study demonstrated that the perfusion index is a useful and reliable tool in assessing the effectiveness of brachial plexus block. It was found that the perfusion index is as effective as the conventional methods to assess the sensory and motor blockade and needed lesser patient cooperation and was less time consuming and hence superior to the conventional methods. A perfusion index ratio of more than or equal to 1.61 could be considered a cut-off to predict a successful peripheral nerve block.

Keywords: Perfusion Index, Supraclavicular Brachial Plexus Block, Ultrasound-guided block.

Introduction

Peripheral nerve blocks are commonly utilized for surgical anesthesia as well as post-operative analgesia in upper and lower limb procedures. Regional anesthesia, particularly peripheral nerve blocks, has played an increasingly important role in anesthetic practice during the last two decades. Regional anesthesia is important for the future of outpatient surgery or ambulatory anesthesia, both as an inherent component of the anesthetic method and for postoperative analgesia. One of the most often utilized peripheral nerve blocks for anesthesia during upper extremity surgeries is the ultrasound-guided supraclavicular block (SCB). Because of the tight positioning of the plexus parts in this region, it has the most extensive amount of sensory blockade of all brachial plexus methods and single puncture technique. [1] Sensory and motor function are typically used to measure the effectiveness of peripheral nerve blocks. However, this procedure is subjective, time-consuming, and cannot be used in patients who are under GA, profound sedation, or otherwise unable to offer input. Several objective approaches have been established, including thermographic temperature measurement, laser Doppler perfusion imaging, and skin electrical resistance. These approaches rely on assessing sympathetic block and the resulting physiological changes such as vasodilation, blood flow alterations, and skin temperature. [2] However, most of these objective procedures need specialized and costly equipment. The perfusion index (PI) is a straightforward, objective, and non-invasive measure for assessing success. The perfusion index (PI) derived from a pulse oximeter, non-invasively reflects the ratio between pulsatile and non-pulsatile blood flow in peripheral tissue. It is determined as a percentage or absolute number by dividing the ratio of arterial blood flow (pulsatile) to venous, capillary, and tissue blood flow (non-pulsatile blood flow). [3] It is used to examine peripheral perfusion dynamics caused by changes in peripheral vascular tone and is measured using a specific pulse oximeter. It is now accessible on other displays as well. [4] It serves as a marker of peripheral perfusion and as an index of sympathetic stimulation. This study is aimed to evaluate whether the perfusion index is a reliable and objective method of assessing the effectiveness of regional anesthetic blocks.

Material and Methods

This cross-sectional study was conducted in the Department of Anesthesia, Osmania Medical College, and General Hospital, Hyderabad. Institutional Ethical approval was obtained for the study. Written consent was obtained from all the patients included in the study.

Inclusion criteria

1. Patients were posted for upper limb, hand, wrist, and forearm surgeries.
2. American Society of Anesthesiologists Physical Status (ASA – I, II) patients
3. Patients Age-18 - 60 yrs of either sex
4. Patients with the informed written consent

Exclusion criteria

1. Patients with diabetes mellitus.
2. Patients with peripheral vascular diseases.
3. Patients with neuropathies.
4. Patients with any contraindication to regional anesthesia technique including patient refusal, known hypersensitivity to the local anesthetic, or skin infection at the site of needle insertion.

A total of n=60 cases were included in the study following the inclusion and exclusion criteria. They were randomly allotted into two *Group C (Conventional)* n=30 receive Conventional Supraclavicular brachial plexus block Landmark guided. *Group U (Ultrasound-guided)* n=30

To receive Ultrasound-guided Supraclavicular brachial plexus block. Patients will be subjected to pre-anesthetic evaluation. Routine monitors will be connected (ECG, Automated NIBP, pulse oximeter). Baseline pulse rate, BP readings , and SpO_2 values will be recorded. Premedication with IV Midazolam 2 mg/kg and IV

Fentanyl 1 µg /kg will be given after securing IV access. Under strict aseptic precautions Ultrasound-Guided Supraclavicular block will be administered to n=30 patients (Group USG) and the Paresthesia technique supraclavicular block to 30 patients (Group C) with 30 ml of local anesthetic solution (0.5% Bupivacaine 20 ml and 2% Lignocaine 10 ml). After performing block perfusion index will be recorded at times 10, 20, and 30 minutes in both blocked limb and unblocked limb using two separate pulse oximeters of the same manufacturer. At time t=0, i.e end of nerve block technique corresponding to the removal of needle patient response to pinprick and motor blockade was assessed every ten min for the next 30 min. Pinprick was assessed using a 22-gauge needle and compared with the unblocked limb and graded using Hollmen's scale for the sensory blockade.

The motor response was assessed with a modified Bromage scale. A standard pulse oximeter probe (Philips) capable of measuring perfusion index was kept on the blocked and unblocked limb at least 10 min before the procedure The probe remained in situ for the next 30 min. Values were measured every 10 minutes. Perfusion index was expected to increase in the blocked limb because of vasodilation resulting from sympathetic blockade. No change in perfusion index values was noticed in the unblocked limb. At the end of 30 min, if the patient complained of pain while assessing the surgical site for pain using surgical forceps or the need to supplement the block or need for general anesthesia was considered a failed block. A block was considered successful when the patient had sensory and motor blockade of grade 3, wherein the patient had no pain to surgical stimuli applied by a toothed forceps after 30 minutes of the block and when there was no need to supplement the block and or convert it to general anesthesia for the conduct of the surgery. The changes in perfusion index in successful blocks were compared and used to derive a cut-off value for perfusion index ineffective nerve blocks.

Data analysis: Data were entered in a Microsoft Excel sheet. With the SPSS software analysis of data was done. Qualitative data are expressed in proportion and percentage. Quantitative data are expressed as mean and standard deviation. ANOVA test was used for statistical analysis. For all statistical evaluations, a two-tailed probability of value $p<0.05$ was considered significant.

Results

In this study out of n=30 patients were placed in the USG group majority belonged to the age group between 31 - 40 years with 33.3 percent of cases. Among the n=30 patients placed in the Conventional Group majority belonged to the age group between 41 - 50 years with 36.7% of cases given in table 1. The mean age of patients in the USG group was 40.5 ± 4.5 years and the mean age of patients in the conventional group was 38.68 ± 8.5 years. There was no statistically significant difference between the two groups.

Table 1: Age-wise distribution of cases studied

Age Group	*Group U*	Percentage	*Group C*	Percentage

	(USG Guided) n=30		*(Conventional)* n=30	
20 – 30	8	26.7	5	16.7
31 – 40	10	33.3	10	33.3
41 – 50	7	23.3	11	36.7
51 – 60	5	16.7	4	13.3
Total	30	100	30	100

The total number of males in the USG group was n=16(53.3%) and females were n=14(46.7%) similarly in the conventional group the total number of males was n=14(46.7%) and females were n=16(53.3%). The mean weight of cases in the USG group was 68.58 ± 10.5 Kg and n=9(30%) of cases were found to be obese with BMI > 30 Kg/m^2. The mean weight of the patients in the conventional group was 62.42 ± 7.5 Kgs and n=5(16.67%) was found to be obese with BMI > 30 kgs/m^2. Paired-t-test was used to compare the perfusion index in the blocked and unblocked limb s in successful cases (table 2). The mean value of the perfusion index of the blocked limb came out to be 12.6, whereas that of the unblocked limb remained constant. The was significant for perfusion index of the blocked limb as the p-value derived was <0.0001

Table 2: Comparison of Perfusion Index at different time intervals between Blocked limb and Unblocked limb for Successful cases in the USG group

Perfusion Index (PI)		*Mean*	*SD*	*Mean Difference*	*t*	*P-value*
Baseline PI (0)	Blocked limb	3.11	0.78	0.02	0.63	0.53
	Unblocked limb	3.13	0.74			
PI (10) 10 Min	Blocked Limb	6.83	0.88	3.6	24.8	<0.0001*
	Unblocked limb	3.13	0.74			
PI (20) 20 Min	Blocked limb	9.71	1.14	6.5	30.4	<0.0001*
	Unblocked limb	3.13	0.74			
PI (30) 30 Min	Blocked Limb	12.6	1.56	9.5	33.9	<0.0001*
	Unblocked Limb	3.13	0.74			

* Significant

Paired-t-test was used to compare the perfusion index in blocked and unblocked limbs in successful cases (table 3). The mean value of the perfusion index of the blocked limb came out to be 10.6, whereas that of the unblocked limb remained constant. The was significant for perfusion index of the blocked limb in the conventional group.

Table 3: Comparison of Perfusion Index at different time intervals between Blocked limb and Unblocked limb for Successful cases in the conventional group

Perfusion Index (PI)		*Mean*	*SD*	*Mean Difference*	*t*	*P-value*
Baseline PI (0)	Blocked limb	2.47	0.66	0.00	1.0	0.61
	Unblocked limb	2.47	0.66			
PI (10) 10 Min	Blocked Limb	5.30	1.31	2.82	17.3	<0.0001*
	Unblocked limb	2.47	0.66			
PI (20) 20 Min	Blocked limb	7.94	1.64	5.47	19.2	<0.0001*
	Unblocked limb	2.47	0.66			
PI (30) 30 Min	Blocked Limb	10.6	2.64	8.22	17.7	<0.0001*
	Unblocked Limb	2.47	0.66			

* Significant

In the conventional group, baseline perfusion indices in both blocked and unblocked limbs were 2.47 each. After the administration of the block, a significant increase was seen in the

perfusion index of the blocked limb compared to the unblocked limb in successful cases. The perfusion index value in the blocked limb was found to be 5.3 at 10 minutes, 7.9 at 20 minutes, and 10.6 at 30 minutes, whereas the perfusion index of the unblocked limb remained constant at a value of 2.47. There was a significant perfusion index of the blocked limb in a conventional group with a p-value of <0 .0001.

Table 4: Comparison of Perfusion index of Blocked Limb at different time intervals between USG and Conventional blocks for Successful blocks.

Perfusion Index (PI)		*Mean*	*SD*	*Mean Difference*	*t*	*P-value*
Baseline PI (0)	USG	3.11	0.78	0.63	3.39	0.58
	Conventional	2.47	0.66			
PI (10) 10 Min	USG	6.83	0.88	1.53	5.29	<0.0001*
	Conventional	5.30	1.31			
PI (20) 20 Min	USG	9.71	1.43	1.76	4.83	<0.0001*
	Conventional	7.94	1.62			
PI (30) 30 Min	USG	12.65	1.59	1.96	3.49	<0.0001*
	Conventional	10.69	2.64			

* Significant

Paired-t-test was used to compare the perfusion index in the blocked and unblocked limb in successful cases. The mean value of perfusion index of the blocked limb in the USG group came to be 12.6 and the mean value of perfusion index of the blocked limb in conventional Group came out to be 10.6, whereas that of the unblocked limb remained constant. The values were significant for the perfusion index of the blocked limb. In both groups, serial increases in perfusion index values were observed after successful blocks. In the Ultrasound group perfusion index value at 30 minutes increased to 12.6 from the baseline value of 3.13 while in the conventional group the value observed at 30 minutes was 10.7 in comparison to the baseline value of 2.47. The values between perfusion index value and successful block were found to be highly significant with a p-value of < 0.001. Among the N=30 patients in the USG group, the block was successful in n=29 and they achieved Hollmen grade 3 sensory block (pinprick recognized as light touch with a blunt object) but in one patient block failed and was classified as Holmen Grade 1. Normal sensation of pinprick). In the Conventional Group, n=27 patients achieved Hollmen Grade 3 sensory block while two patients had grade 2 and one patient grade 1 sensory block. No significant difference was found between USG and Conventional Block. Motor block was assessed using Modified Bromage Scale. In the USG group, 29 patients achieved grade 3 motor block and in the Conventional group, n=27 patients achieved grade 3 block. No significant difference was found between USG and Conventional Block.

Discussion

The supraclavicular approach to Brachial plexus block is a popular technique for upper limb anesthesia. It can be done either by landmark guided or ultrasound-guided technique. Conventional methods for the evaluation of block success are very time-consuming. This study is to compare whether a change in perfusion index over time can be used to predict successful blocks in both ultrasound-guided and conventional techniques and to provide a cut-off value for Perfusion index and Perfusion Index Ratio. The Perfusion Index (PI) can be considered an objective measure in predicting the success of peripheral nerve blocks. This study points towards the idea that the perfusion index and perfusion index ratio can be useful tools in assessing the effectiveness of brachial plexus blocks. A successful block was parallel by an

increased perfusion index when compared with Unblocked limb at 10, 20, and 30 min after anesthesia injection. The perfusion index of the blocked limb in successful cases at different intervals of time was analyzed using paired t-test. A successful block was found to be associated with a rise in perfusion index over time due to Profound vasodilatation. To derive a cut off the PI ratio was taken since the baseline PI varies from person to person and the change in PI following the peripheral nerve block is also not a constant. The perfusion index ratio (ratio of perfusion index at 10 minutes to baseline PI) to determine the adequacy of the block was considered due to the high variability in baseline PI. Lanz et al., [5] in a similar study demonstrated that blocking the brachial plexus with a method directed towards the first rib (at the level of trunks and divisions of the brachial plexus) offers the most reliable, consistent, and predictable upper extremity anesthesia. It can be administered after inducing paresthesia or using a nerve stimulator. One of the most often mentioned disadvantages of the paresthesia technique is that it causes patient discomfort when eliciting paresthesia and that its effectiveness is greatly dependent on the patient's participation. According to Morros et al., [6] the use of ultrasonography in regional anesthesia necessitates the acquisition of new information and abilities not just by anesthesiologists in training, but also by anesthesiologists with expertise in neurostimulation-guided peripheral nerve blocks. Our study found that the initiation of sensory blocking in all main nerve distributions was identical in the conventional and ultrasonic groups. Honnannavar KA et al., [7] also made similar observations in their study. Abdelnasser et al., [8] in their study on n=77 patients using ultrasonography (USG) guided SCB, found a continuous rise in the mean PI from baseline (2.8) to 30 minutes (7.1) in the blocked arm. They reported a 3.3 cut-off value for PI at the tenth minute and a 1.4 PI ratio. This variation in the PI ratio cut-off value may be related to a larger baseline PI in the current research. Similarly, two further investigations found a continuing rise. The Mean PI from baseline to 30 minutes (9.56) in the blocked arm, with a measured median PI ratio of 7.05. [9, 10] In this study we found the mean PI in the blocked arm from baseline to 30 minutes was 12.6. We found in both the groups there is a continuous increase of PI from baseline to 30 minutes. Sebastiani *et al*., [11] reported a continuous increase in PI from baseline (0.2) up to 15 minutes (2.2) with US-guided interscalene block. Kus *et al*., [12] also observed an increase in mean PI from baseline (1.8) up to 20 minutes (3.7), and then it started decreasing and continued to decrease up to 30 minutes with US-guided infraclavicular block. Peripheral nerve blocks give good analgesia and are also used exclusively for anesthesia. These have now become a primary clinical approach for anesthesiologists to avoid the airway during the coronavirus pandemic for any procedures that are viable under regional blocks. [13]

The limitations of the current study were Photoplethysmographic analysis is sensitive to patient movement and PI decreases due to sympathetic stimulation due to several factors like stress, anxiety, and systemic and local pathological factors, which in turn induces vasoconstriction. In this study, the baseline PI values were recorded with utmost care to avoid patient movement, especially while recording baseline values, and all patients were counseled before taking them up for surgery to allay anxiety. PI values may vary when measured with different types of monitors. However, in this study, only a Philips monitor was used.

Conclusion

The study demonstrated that the perfusion index is a useful and reliable tool in assessing the effectiveness of brachial plexus block. It was found that the perfusion index is as effective as the conventional methods to assess the sensory and motor blockade and needed lesser patient cooperation and was less time consuming and hence superior to the conventional methods. A perfusion index ratio of more than or equal to 1.61 could be considered a cut-off to predict a

successful peripheral nerve block. Due to high variability in single values of PI, PI ratio was considered more effective in assessing the adequacy of peripheral nerve blocks.

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