Section: Anaesthesiology

Original Research Article

# PREDICTING SUCCESSFUL ULTRASOUND GUIDED COSTOCLAVICULAR BRACHIAL PLEXUS BLOCK BY PERFUSION INDEX USING PULSE OXIMETRY

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## Abstract

**Background:** Perfusion index can considered as an objective measure for peripheral perfusion that can predict peripheral block success. Early and accurate detection of peripheral block success would enable rapid corrective action this would save the operating room time and improve patient satisfaction. Assessment the success sensory and motor block using conventional methods is time consuming and also it needs patient co-operation. This study was conducted to evaluate PI as an indicator for assessing success of USG-guided supraclavicular block. **Aim and objective:** to evaluate PI as an indicator for assessing success of USG-guided supraclavicular block (SCB), compare the change in PI value between successful and unsuccessful SCBs and to assess grades of sensory/motor block and also any associated complications. **Materials and Methods:** This was a prospective observational study conducted in a tertiary care hospital among the 68 patients underwent upper limb surgery. Purposive sampling method was used for selection of patients for the study. The total 68 patient were randomly divided in to unblocked arm control group (34 patients) and USG-guided costoclavicular brachial plexus (CCBP) block group (34 patients). The supraclavicular nerve block was performed under guidance of a linear transducer (8 - 14MHz) over the supraclavicular fossa in the coronal oblique plane immediately superior to the midclavicular point. The limb was evaluated for block success every 3 min for the sensory block and every 5 min for the motor block. The PI was recorded at baseline and at 0, 5, 10, 20, and 30 minutes after local anesthetic injection in both the blocked limb and the contralateral unblocked limb using two separate pulse oximeters. Data was analyzed by descriptive statistics and chi-square test. **Results:** As the time progresses from the 2 minutes to 30 minutes, it was observed that means of perfusion index (PI) was increased in the USG-guided CCBP block group where as in the unblocked arm control group, the means of perfusion index (PI) was remained closes to the base line readings of the means of perfusion index. Perfusion index monitoring helps to evaluate the success of ultrasound guided supraclavicular block for upper limb surgery. **Conclusion:** Perfusion index (PI) is useful for the assessment of the success of ultrasound guided supraclavicular block among the patients undergoing upper limb surgery.

## INTRODUCTION

Assessment the success sensory and motor block using conventional methods is time consuming and also it needs patient co-operation. Objective method such as increase in perfusion index is used to predict the success of ultrasound-guided supraclavicular block. Ultrasound-guided supraclavicular nerve block is a popular approach for anesthesia for upper limb surgeries. The success of peripheral nerve blocks is usually assessed by sensory and motor function. But this method is subjective, time consuming and cannot be done in patients under general anaesthesia (GA), deep sedation or


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otherwise unable to provide feedback. Various objective methods like thermographic temperature measurement, laser Doppler perfusion imaging and skin electrical resistance have been developed.[1]

Thermographic temperature measurement with an infrared camera, compared with patient response to cold and pinprick, as a means of assessing the success or failure of axillary blockades. Thermography had higher combined values for sensitivity, specificity, and positive and negative predictive values than both cold and pinprick at all time intervals.[2] A laser Doppler perfusion imager (LDPI) for evaluation of skin blood flow is presented and its use illustrated in two cases with a presumptive diagnosis of reflex sympathetic dystrophy (RSD) treated with local anesthetic sympathetic blocks.[3]

After induction of general anesthesia, the PI increased in the unblocked arm while it remained relatively constant in the blocked arm, thus reducing the difference in the PI. A fluid challenge resulted in a decrease in PVI values in both arms.[4] The positive correlations between changes in PI and both presence of clinical signs and changes in blood flow in the skin microcirculation indicate a sympatholytic effect, suggesting that the PI could be useful in determination of the efficacy of SGB.[5]

The perfusion index (PI) derived from a pulse oximeter has been used for assessing peripheral perfusion dynamics due to changes in peripheral vascular tone.[6] Perfusion index (PI) is a new simple, objective and non-invasive method for evaluation of the success of central neuraxial and peripheral nerve blocks.[7]

Perfusion index can considered as an objective measure for peripheral perfusion that can predict peripheral block success. Early and accurate detection of peripheral block success would enable rapid corrective action this would save the operating room time and improve patient satisfaction.[8]

However, most of the objective methods are either time consuming or dependent on sophisticated equipment. Perfusion Index is an indirect, non invasive and continuous measure of peripheral perfusion that provides useful information to the practicing physician in several clinical settings.

Pulse oxymeter provides a relatively simple means to continuously monitor PI in conjunction with other critical parameters, i.e., oxygen saturation and pulse rate. The perfusion index (PI) is a numerical value for the ratio between pulsatile and nonpulsatile blood flow or static blood in peripheral tissue, provides an indication of peripheral perfusion at the sensor site.

The present study with the aim to evaluate PI as an indicator for assessing success of USG-guided supraclavicular block (SCB), compare the change in PI value between successful and unsuccessful SCBs and to assess grades of sensory/motor block and also any associated complications.

## MATERIALS AND METHODS

A prospective observational study was conducted among the 68 patients underwent upper limb surgery in a tertiary care hospital. The objective of this study is to evaluate PI as an indicator for assessing success of USG-guided supraclavicular block (SCB), compare the change in PI value between successful and unsuccessful SCBs and to assess grades of sensory/motor block and also any associated complications. Purposive sampling method was used for selection of patients for the study. The total 68 patient were randomly divided in to unblocked arm control group (34 patients) and USG-guided costoclavicular brachial plexus (CCBP) block group (34 patients).

A routine pre-operative assessment was ensured and the whole procedure was explained and informed written consent was taken. On entering in the operating room, standard intraoperative monitors such as electrocardiogram, pulse oximeter on both upper limbs, and non-invasive blood pressure were attached and baseline parameter was recorded. A baseline assessment of pin prick sensation was made in the distribution of each of ulnar, median, radial, and musculocutaneous nerves before the performance of the block. The supraclavicular nerve block was performed under guidance of a linear transducer (8 - 14MHz ;) over the supraclavicular fossa in the coronal oblique plane immediately superior to the midclavicular point. The block was induced in the semi-sitting position, with the head of the patient turned away from the side to be blocked. A 22-gauge 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. Volume of 25ml of local anaesthetic (bupivacaine 0.5%, 12.5ml and lidocaine 2%, 12.5ml) was injected under vision strictly perineural to surround all the nerve cords. The limb was evaluated for block success every 3 min for the sensory block and every 5 min for the motor block.

Patient's hemodynamic variables like heart rate (HR), systolic blood pressure, diastolic blood pressure, and oxygen saturation (SPO2) were monitored every 5 minutes. HR of less than 60 considered as bradycardia and treated with atropine 1 mg IV, Blood pressure of less than 20% of baseline considered as hypotension and treated with mephentermine 6 mg IV bolus along with IV fluids.

The perfusion index (PI) is a numerical value for the ratio between pulsatile and nonpulsatile blood flow measured by a pulse oximeter. PI which is automatically calculated by pulse oximetry and provides an indication of peripheral perfusion at the sensor site (finger) has been shown to be a useful method to evaluate axillary or sciatic block in patients scheduled for limb surgery. The limb was evaluated for block success every 5 minutes. for the


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sensory block and motor block. Sensory function was assessed using pinprick in the dermatomal areas supplied by the four main nerves (median nerve, radial nerve, ulnar nerve, and musculocutaneous nerve). Motor block was assessed by the ability to flex the elbow and the hand against gravity. The supraclavicular block was considered successful with regard to neurological examination if brachial plexus dermatomes (C5–T1) were completely blocked.

PI was measured using pulse oximetry applied on the index finger. The PI was recorded at baseline and at 0, 5, 10, 20, and 30 minutes after local anesthetic injection in both the blocked limb and the contralateral unblocked limb using two separate pulse oximeters. PI ratio, i.e., PI at 10 minutes to PI at baseline was also calculated.

**Statistical Analysis:** Statistical analysis of the data will be performed using SPSS23.0. Descriptive statistics will be expressed using frequency, percentage, mean and standard deviation. Association between the categorical variables will be found using Chi square test. A p value <0.05 will be considered statistically significant.

## RESULTS

In our study, total 68 patients underwent upper surgery were included. These 68 patients were randomly allocated in to unblocked arm control group (34 patients) and USG-guided costoclavicular brachial plexus (CCBP) block group (34 patients). The mean age (mean ± standard deviation) of the total 68 patients was 40.69 ± 10.95. The mean age of unblocked arm control group and USG-guided costoclavicular brachial plexus (CCBP) block group was found to be 42.24 ± 11.468 and 39.15 ± 10.35 respectively. Among total 34 patients in unblocked arm control group, 16 (47.1%) were males and 18 (52.9%) were females. Similarly among total 34 patients in USG-guided CCBP block group, 19 (55.9%) were males and 15 (44.1%) were females. [Figure 1]

**Table 1: Age group wise distribution of patients underwent upper limb surgery (N=68)**

| Age group (in years) | Patients underwent upper limb surgery | | Total (%) |
|---|---|---|---|
| | Unblocked arm (Control) group (%) | USG-guided costoclavicular brachial plexus (CCBP) block group (%) | |
| 18 to 25 years | 5 (55.5) | 4 (44.5) | 9 (13.2) |
| 26 to 35 years | 4 (30.8) | 9 (69.) | 13 (19.2) |
| 36 to 45 years | 12 (54.5) | 10 (45.5) | 22 (32.3) |
| 46 to 55 years | 8 (47.1) | 9 (52.9) | 17 (25) |
| 56 to 60 years | 5 (71.4) | 2 (28.6) | 7 (10.3) |
| **Total** | **34** | **34** | **68** |

Among total 68 patients, 22 (32.3%) of the patients belonged to age group 36 to 55 years, among which 12 (54.5%) were in unblocked arm control group and 10 (45.5%) were in USG-guided CCBP block group. In this study, 9 (13.2%) patients were from the 18 to 25 years of age group and 7 (10.3%) of the patients were from the 56 to 60 years. [Table 1]

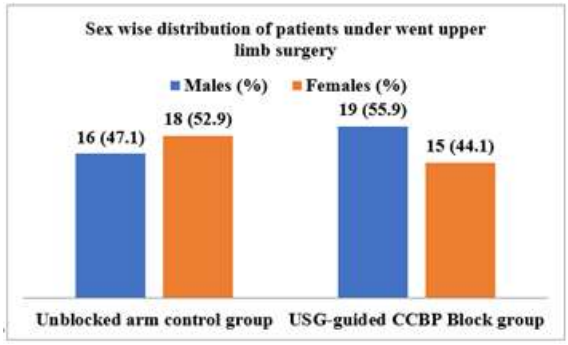


**Figure 1: Sex wise distribution of patients under went upper limb surgery (N=68)**

**Table 2: Means of Perfusion index (PI) of the patients received USG-guided costoclavicular brachial plexus (CCBP) block group underwent upper limb surgery (N=68)**

| Time intervals in minutes | Means of Perfusion index (PI) of the patients underwent upper limb surgery in USG-guided CCBP block group (mean ± SD) |
|---|---|
| **Baseline** | 1.76 ± 0.41 |
| **At 2 minutes** | 2.90 ± 0.44 |
| **At 4 minutes** | 3.63 ± 0.42 |
| **At 6 minutes** | 4.38 ± 0.39 |
| **At 8 minutes** | 4.99 ± 0.43 |
| **At 10 minutes** | 5.60 ± 0.57 |
| **At 15 minutes** | 6.19 ± 0.51 |
| **At 20 minutes** | 6.97 ± 0.56 |
| **At 25 minutes** | 9.18 ± 0.68 |
| **At 30 minutes** | 10.85 ± 0.60 |
| **Δ PI (PI at 10 minutes: PI at baseline)** | 3.32 ± 0.58 |


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The mean of perfusion index (PI) at baseline was 1.76 ± 0.41 1 in ultrasonography guided costoclavicular brachial plexus block (USG guided CCBP block) group of patients undergoing upper limb surgery. After 2 minutes of giving the USG-guided CCBP block to the patients, the mean of perfusion index (PI) was found to be 2.90 ± 0.44. The perfusion index was measured at different time intervals, the perfusion index (PI) was increased as the time interval progresses from 2 minutes to 30 minutes. The mean of perfusion index (PI) at 30 minutes was increased to 10.85 ± 0.60. The Δ PI (PI at 10 minutes: PI at baseline) was found to be 3.32 ± 0.58. [Table 2]

**Table 3: Means of Perfusion index (PI) of the patients underwent upper limb surgery (N=68)**

| Time intervals in minutes | Means of Perfusion index (PI) of the patients underwent upper limb surgery | |
|---|---|---|
| | USG-guided CCBP block group (mean ± SD) | Unblocked arm group (mean ± SD) |
| **Baseline** | 1.76 ± 0.41 | 1.99 ± 0.61 |
| **At 2 minutes** | 2.90 ± 0.44 | 1.85 ± 0.44 |
| **At 10 minutes** | 5.60 ± 0.57 | 1.90 ± 0.59 |
| **At 20 minutes** | 6.97 ± 0.56 | 1.91 ± 0.51 |
| **At 30 minutes** | 10.85 ± 0.60 | 1.77 ± 0.46 |

The means of perfusion index (PI) at baseline were 1.76 ± 0.41 and 1.99 ± 0.61 in Ultrasonography guided costoclavicular brachial plexus block (USG guided CCBP block) group and Unblocked arm control group respectively. At 2 minutes, the means of perfusion index (PI) was increased (2.90 ± 0.44) slightly after giving the anaesthesia block to the patients in the USG-guided CCBP block group as compared to that of in the unblocked arm control group1.85 ± 0.44. At 30 minutes, the means of perfusion index (PI) was increased to 10.85 ± 0.60 in the USG-guided CCBP block group and 1.77 ± 0.46 in the unblocked arm control group. As the time progresses from the 2 minutes to 30 minutes, it was observed that means of perfusion index (PI) was increased in the USG-guided CCBP block group where as in the unblocked arm control group, the means of perfusion index (PI) was remained closes to the base line readings of the means of perfusion index. [Table 3]

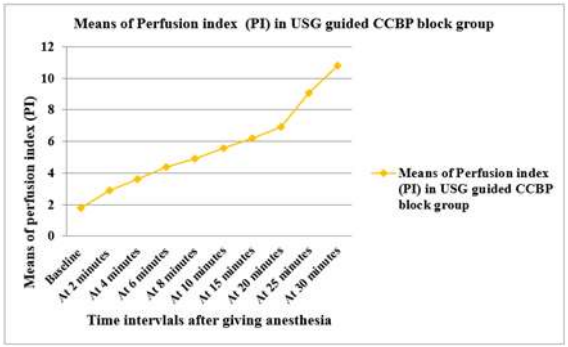


**Figure 2: Multiple line diagram showing the means of perfusion index (PI) in USG-guided costoclavicular brachial plexus (CCBP) block group and unblocked arm control groups among the patients underwent upper limb surgery. (N=68)**

The multiple line diagram is showing the relationship between the means of perfusion index (PI) and the time intervals after administration of anesthesia among the patients of USG-guided CCBP block group underwent upper limb surgery. At the base line the mean of perfusion index (PI) was 1.76 among the patients of USG-guided CCBP block group. After giving anaesthesia block to the patients, and also after 15 minutes, the means of perfusion index (PI) was increased to 6.19 among the patients in USG-guided CCBP block group. The diagram shows that the means of perfusion index (PI) was again start increasing as the time period progresses towards the 30 minutes of time period among the patient administered with USG-guided CCBP block for performing upper limb surgery. [Figure 2]

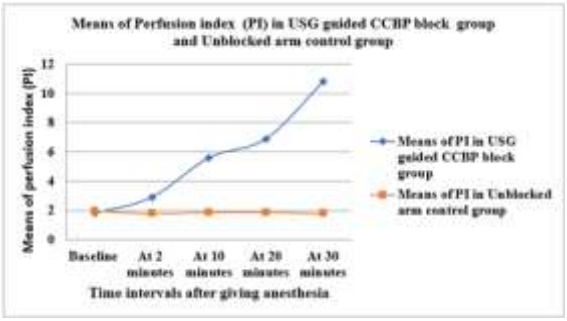


**Figure 3: Multiple line diagram showing the means of perfusion index (PI) in USG-guided costoclavicular brachial plexus (CCBP) block group and unblocked arm control groups among the patients underwent upper limb surgery. (N=68)**

The multiple line diagram is showing the relationship between the means of perfusion index (PI) and the time intervals after administration of anesthesia among the USG-guided CCBP block group and unblocked arm control group. At the base line the mean of perfusion index (PI) were 1.76 and 1.99 in USG-guided CCBP block group and unblocked arm control group respectively. After giving anaesthesia block to the patients, and also after 10 minutes, the means of perfusion index (PI) was increased among the patients in USG-guided CCBP block group whereas the means of perfusion index (PI) was remained close to the baseline level in the unblocked arm control group. The diagram shows that the means of perfusion index (PI) was again start increasing as the time period progresses towards the 30 minutes of time period. [Figure 3]


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## DISCUSSION

In our study, total 68 patients underwent upper surgery were included. These 68 patients were randomly allocated in to unblocked arm control group (34 patients) and USG-guided costoclavicular brachial plexus (CCBP) block group (34 patients). The mean age (mean ± standard deviation) of the total 68 patients was 40.69 ± 10.95. Among total 34 patients in unblocked arm control group, 16 (47.1%) were males and 18 (52.9%) were females. Similarly among total 34 patients in USG-guided CCBP block group, 19 (55.9%) were males and 15 (44.1%) were females. In the study done by Singh M et al,[8] the mean age was 37.37±15.01 years and Majority of the patients are in the age group 31 - 40 years of age.

In this we found that, at 2 minutes, the means of perfusion index (PI) was increased (2.90 $\pm$ 0.44) slightly after giving the anaesthesia block to the patients in the USG-guided CCBP block group as compared to that of in the unblocked arm control group1.85 $\pm$ 0.44. Similar findings in the study conducted by Kus, A. et al,[9] showed that, the baseline values of PI ranged from 0.6 to 4.7 % in 44 patients for whom infraclavicular block was effective and 1.8 to 2.4 % in 2 patients for whom infraclavicular block failed. At 20 and 30 min, perfusion index increased by 133 ± 125 % and 155 ± 144 % from baseline. The perfusion index is a predictor of infraclavicular block success. Perfusion index monitoring may provide a highly valuable tool to quickly evaluate the success of regional anesthesia of the upper extremity in clinical practice.

At 30 minutes, the means of perfusion index (PI) was increased to 10.85 $\pm$ 0.60 in the USG-guided CCBP block group and 1.77 $\pm$ 0.46 in the unblocked arm control group. As the time progresses from the 2 minutes to 30 minutes, it was observed that means of perfusion index (PI) was increased in the USG-guided CCBP block group where as in the unblocked arm control group, the means of perfusion index (PI) was remained closes to the base line readings of the means of perfusion index. Narasimhan MK et al,[10] conducted a prospective observational study showed that, 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.

Study conducted by A. Sebastiani et al,[4] showed that, in the 25 patients with successful blocks, the difference between the PI values in the blocked arm and the PI values in the contralateral arm increased within five minutes of the application of the local anesthetics (P\0.05) and increased progressively until 15 min. After induction of general anesthesia, the PI increased in the unblocked arm while it remained relatively constant in the blocked arm, thus reducing the difference in the PI. A fluid challenge resulted in a decrease in PVI values in both arms. A study done by N Gopal Reddy et al,[11] 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.

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

C. Bergek et al,[12] conducted a study showed that, during the last 10 minutes of the study, Plethysmographic measurement of haemoglobin concentration (SpHb) had increased by 8.6%. The PVI decreased by 54%, and PI increased by 188% in the blocked arm (median values). In the non-blocked arm, these parameters did not change significantly. Brachial plexus block significantly altered SpHb, PVI, and PI, which indicates that regional nervous control of the arm greatly affects plethysmographic measurements obtained by the Radical-7. After the brachial plexus block, SpHb increased and PVI decreased. Our study showed that the means of perfusion index (PI) was again start increasing as the time period progresses towards the 30 minutes of time period among the patient administered with USG-guided CCBP block for performing upper limb surgery.

In our study, At the base line the mean of perfusion index (PI) were 1.76 and 1.99 in USG-guided CCBP block group and unblocked arm control group respectively. After giving anaesthesia block to the patients, and also after 10 minutes, the means of perfusion index (PI) was increased among the patients in USG-guided CCBP block group whereas the means of perfusion index (PI) was remained close to the baseline level in the unblocked arm control group. The diagram shows that the means of perfusion index (PI) was again start increasing as the time period progresses towards the 30 minutes of time period. A study conducted by Veena et al,[1] showed that, the perfusion index increased in blocked arm after 5 minutes compared with unblocked arm and also to its baseline value. Both perfusion index and perfusion index ratio in blocked arm were found statistically significant

According to the study done by Lal et al,[7] conducted a study found that, the mean PI increased continuously from baseline and reached the maximum at 10 minutes and then slightly decreased up to 30 minutes, but values at subsequent time intervals were quite high as compared to baseline. PI is an objective and faster indicator for evaluating success of USG- guided SCB. A cut-off value of 3.25 for PI and 3.03 for PI ratio showed a fairly good ability with high sensitivity and specificity for predicting the success of SCB.


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Singh, M et al,[8] conducted a prospective observational study found that the perfusion index was significantly higher in blocked limbed at all time points. Regarding the quality of block 90% of the patient's attained successful block in which significant increase in PI ratio was observed when compared to 10% of the patients with unsuccessful block in which no significant changes in PI ratio was observed. PI significantly increased in blocked limb who received an effective block but not on unblocked limb. A study conducted by Abdelnasser et al,[13] also showed that PI index ratio at 10 minutes have a sensitivity and specificity of 100% for block success.

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