

Original Research Article

PERFUSION INDEX AS A TOOL TO PREDICT SUCCESSFUL SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK

C.Chandru¹, K.Bhuvaneswari¹, Manoj Prabakaran.¹

¹Assistant Professor, Department of Anaesthesiology, Government Medical College & ESI Hospital, Coimbatore, Tamilnadu, India.

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Corresponding Author:

Dr. C.Chandru,
Assistant Professor, Department of
Anaesthesiology, Government Medical
College & ESI Hospital, Coimbatore,
Tamilnadu, India.
Email: chandru24c@gmail.com

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ABSTRACT

Background: Brachial plexus block (BPB) is one of the most commonly used peripheral nerve blocks. Brachial plexus block is considered to be an alternate procedure to general anaesthesia to achieve analgesia of upper limb. Supraclavicular Brachial plexus block is considered to be a better approach than performing brachial plexus block at other levels. The objective is to study and predict successful ultrasound guided supraclavicular brachial plexus block using perfusion index in patients undergoing upper limb surgeries.

Materials and Methods: A Prospective observational study was done between February 2020 and September 2021 at Mahatma Gandhi Memorial Government Hospital, Tiruchirapalli among patients posted for Elective upper limb surgeries. Routine pre-anaesthetic checkup, examination, investigations and preoperative procedures were done. Supraclavicular Brachial plexus block was performed in the operating room. Perfusion index was measured at 5, 10 and 15 minutes and perfusion index ratio was calculated. Appropriate statistical tests were performed. Data collected was entered in MS Excel sheet and analysis done by SPSS 23.p value <0.05 is considered as significant.

Results: In our study mean age of study participants was found to be 40 years and 72% were males. Perfusion index at 5, 10 and 15 minutes was significantly high in blocked arm compared to unblocked arm. Linear increase in perfusion index was noticed in the blocked arm starting from 5 minutes to 15 minutes. Perfusion index ratio was significantly high in blocked arm than unblocked arm. Area under receiver operator curve (AUROC) for PI at 15 minutes was 0.84 and it was 0.93 for PIR.

Conclusion: Perfusion index at 15 minutes with a cut-off 6.95 would be a better predictor to predict the success of supraclavicular brachial plexus block. Perfusion index ratio with a cut off value of 2.2 could be used as a predictor to evaluate the success of supraclavicular brachial plexus block.

Keywords: perfusion index, perfusion index ratio, supraclavicular brachial plexus block, sensory, motor.

INTRODUCTION

Brachial plexus block (BPB) is one of the most commonly used peripheral nerve blocks. Brachial plexus block is most often used during surgeries of upper limb, orthopaedic manipulation in upper extremity and also as pain therapy.^[1] Though Brachial plexus block can be performed at various approach including Interscalene block, Supraclavicular block, Infraclavicular block and Axillary block, Supraclavicular approach is

considered to be a better approach than performing Brachial plexus block at other levels because brachial plexus is more compact and superficial in this region, which is easy to approach.^[2,3]

Brachial plexus block at supraclavicular level has low risk of neurological damage, lower rates of hemi-diaphragmatic paresis, Horner's syndrome and hoarseness of voice.^[4-7] The major disadvantage at this level is that the brachial plexus is located proximal to the pleura. Performing supraclavicular block under ultrasound guidance helps to visualize the pleura and to locate the position of the needle

thereby reducing the occurrence of pneumothorax as a complication of supraclavicular brachial plexus block. Hence the usage of ultrasound probe for achieving brachial plexus block is gaining popularity nowadays.^[8]

The major advantage of using ultrasound-guided procedure is that it produces dense analgesia and anaesthesia with minimal dose of local anaesthetics. Onset of achieving anaesthesia and analgesia is also rapid.^[8] Supraclavicular brachial plexus block approach is useful to target trunks and divisions of brachial plexus. For performing supraclavicular block, the patient has to be placed in supine position with the arms kept by the side. Head of the patient has to be turned away from the side of the block. The high frequency ultrasound probe has to be placed in transverse position above the clavicle. The probe helps to visualize carotid artery, internal jugular vein and more laterally the subclavian artery. The needle has to be inserted parallel to the probe from lateral to medial direction and the local anaesthetic agent has to be injected around the nerves in the area which is bordered by subclavian artery, first rib and brachial plexus. During any peripheral nerve block, aspiration has to be performed to ensure that there is no blood to avoid intravascular injection of the local anaesthetic agent. Supraclavicular approach is the best peripheral nerve block that can be used for surgeries of upper extremity. Occurrence of complications like Horner's syndrome and phrenic nerve paralysis is lower than in Interscalene approach. One of the most important complications of supraclavicular approach is the occurrence of pneumothorax. The success of peripheral nerve block is usually assessed using neurological examination by performing sensory and motor test.^[9] But it has its own limitations viz., subjective nature of neurological assessment depends on patients understanding and perception. It also needs cooperation from patient and is a time consuming process. It can be done only when the patient is awake and able to give feedback and cannot be performed in patients those who are under general anaesthesia and those who are not able to give feedback on perception.^[10]

An accurate and reliable method for assessment of nerve block is essential since early detection of success of block would enable the anaesthetist to take corrective actions in the form of block supplementation or administering general anaesthesia in case of need which would save operation room time and it will also improve patient satisfaction.

A successful peripheral nerve block (PNB) would result in blockade of sympathetic nerve fibers and causes a few physiological changes including vasodilatation, increase in blood flow in the area and increase in temperature.^[11]

Many assessment methods have been developed and studied in various research works to improve the objectivity of assessing adequate nerve block in peripheral nerve block procedures. The range of

assessment methods and monitoring includes skin temperature measurement and monitoring, skin electrical resistance, tissue oxygen saturation, Laser Doppler perfusion imaging and perfusion index.^[12-15]

Of the above mentioned techniques for detection of success of nerve blockade, Perfusion Index is a simple, non invasive and easy method 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.

Aims of the study

To study and predict successful ultrasound guided supraclavicular brachial plexus block using perfusion index in patients undergoing upper limb surgeries.

MATERIALS AND METHODS

Study design: Prospective observational study

Study centre: Mahatma Gandhi Memorial Government Hospital, Tiruchirappalli.

Collaborating Department: Department of Orthopaedic Surgery

Study duration: The study was conducted between February 2020 and September 2021

Study population: Patients posted for Elective upper limb surgeries at the study centre.

Inclusion criteria

1. Age between 18 years and 60 years
2. ASA Physical status I & II
3. Patients posted for elective upper limb surgery (elbow / below elbow surgery)

Exclusion criteria:

1. Patient refusal
2. H/o allergy to local anaesthetic drugs
3. Diabetes mellitus
4. Peripheral vascular disease
5. Coagulopathy

Sample size: 60 patients

Study procedure:

After obtaining ethical committee approval, study population underwent pre-anaesthetic check-up with routine and specific investigations before surgery. Informed consent was obtained from all patients who were included in the study. The patients were kept nil per oral for 8 hours before surgery. Patients were monitored by three lead ECG, automated non-invasive blood pressure monitoring, and pulse oximetry. All patients were pre-medicated with Inj.Midazolam (0.03mg/kg) and Inj.Ranitidine 50 mg intravenously. Supraclavicular Brachial plexus block was performed under guidance of a linear transducer over supraclavicular fossa in the coronal oblique plane immediately superior to the mid-clavicular point. The block was induced in supine 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. A volume of 25 ml of local anaesthetic (0.5% Inj.Bupivacaine 12.5 ml and 2% Inj. Lignocaine 12.5 ml) was injected perineural under vision to surround all the nerve cords. Perfusion index (PI) was measured in both blocked and unblocked arm at Baseline, 5 minutes, 10 minutes and 15 minutes. Perfusion Index Ratio (PIR) was calculated. Sensory and motor block was assessed to identify the success of the block. Sensory block was assessed every 3 mins by pinprick and motor block was assessed every 5 mins by the ability of patient to flex the elbow and hand against resistance.

Statistical analysis: The collected data was entered in Microsoft Excel Sheet and transferred to SPSS software for analysis. Statistical difference between two proportions was analysed using chi-square test. To analyse the difference in mean between 2 groups, independent t test was done. 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 block. For all tests of statistical significance, p value of <0.05 was taken as significant.

RESULTS

Mean age of the study participants was 40.58 ± 12.2 years which ranges between 18 years to 60 years. Majority of the patients were in the age group between 41 to 50 years 18(30%). Male were predominant 43(71.7%) and 46(76.7%) of the study participants were in normal body mass index. The mean BMI was found to be $23.1 \pm 1.6 \text{ kg/m}^2$. Majority of the study participants were in ASA PS II 40(67%).

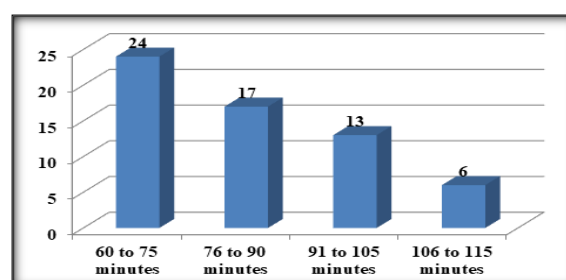


Figure 1: Categorization of patients based on duration of surgery

Mean duration of surgery was 83.5 ± 15.6 minutes with minimum duration of 60 minutes and maximum was 115 minutes.

Table 1: Demographic profile of study participants

	Frequency	Percent
Age (years)		
18 to 30 years	16	26.7
31 to 40 years	12	20.0
41 to 50 years	18	30.0
51 to 60 years	14	23.3
Gender		
Female	17	28.3
Male	43	71.7
BMI		
Normal	46	76.7
Overweight	14	23.3
ASA		
ASA I	20	33
ASA II	40	67

Table 2: Perfusion index in blocked and unblocked arm at baseline, 5 mins, 10 mins, 15 mins and perfusion index ratio

	Blocked	Unblocked	P value
Baseline	2.87 ± 0.84	2.94 ± 0.88	0.66
5 mins	4.08 ± 1.13	3 ± 0.90	0.001*
10 mins	7.41 ± 2.14	2.92 ± 0.872	0.001*
15 mins	8.91 ± 2.52	3.09 ± 0.91	0.000*
Perfusion index ratio	2.61 ± 0.52	1.01 ± 0.07	0.000*

Perfusion index was found more in blocked arm and was found to be statistically significant at 5 mins, 10 mins and 15 mins. Perfusion index ratio was also found more in Blocked arm and it is significant.

Table 3: Association between Haemoglobin and Perfusion Index ratio

Hb	N	Mean	Std. Deviation	p value
Hb				
Anaemia	35	2.63	0.52	0.70
Normal	25	2.58	0.52	
BMI				0.77
Normal	46	2.62	0.56	
Overweight	14	2.57	0.37	

There was no significant association between Haemoglobin level, Body Mass Index and Perfusion Index ratio.

Table 4: Sensory and motor block among patients

	Frequency	Percent
Sensory block		
Adequate	57	95.0
Inadequate	3	5.0
Motor block		
Adequate	57	95.0
Inadequate	3	5.0

Sensory block and motor block was successful in 95% of the patients.

Table 5: Correlation between perfusion index and sensory block in blocked arm at 5,10 and 15 minutes and overall

Perfusion index	Sensory block at 5 mins	Sensory block at 10 mins	Sensory block at 15 mins	Sensory block
Pearson Correlation	0.002	0.185	0.234	0.286*
Sig. (2-tailed)	0.986	0.157	0.072	0.027

There was no significant correlation between perfusion index at 5,10 and 15 minutes and sensory block. There was a significant correlation found between perfusion index ratio and sensory block (overall).

Table 6: Correlation between perfusion index and motor block in blocked arm at 5,10 and 15 minutes and overall

Perfusion index	Sensory block at 5 mins	Sensory block at 10 mins	Sensory block at 15 mins	Sensory block
Pearson Correlation	0.055	0.162	0.207	0.271
Sig. (2-tailed)	0.675	0.215	0.113	0.036*

There was no significant correlation between perfusion index at 5,10 and 15 minutes and motor block. There was a significant correlation found between perfusion index ratio and motor block (overall)

Table 7: Change in perfusion index overtime in the blocked arm

Time	Mean Perfusion index	F value	p value
5 minutes	4.08	44.6	< 0.0001
10 minutes	7.4		
15 minutes	8.9		

Linear increase in perfusion index was noticed in the blocked arm starting from 5 minutes to 15 minutes.

Table 8: Perfusion index at 5 min ,10 min and 15 min and PIR for sensory block

Perfusion index	AUROC (Area under receiver operator curve)	p value
Perfusion index at 5mins	0.465	0.839
Perfusion index at 10mins	0.731	0.180
Perfusion index at 15mins	0.842	0.047*
PIR	0.933	0.012*

Area under receiver operator curve (AUROC) for perfusion index was 0.84 at 15 minutes. AUROC for perfusion index ratio was 0.933.

Table 9: Sensitivity and specificity at different perfusion index values at 15 minutes for predicting sensory block.

Perfusion index	Sensitivity	Specificity
6.95	77%	100%
6.75	78%	66%
6.55	80%	66%
6.45	82%	66%
6.3	86%	33%

At the cut-off value of 6.95, perfusion index at 15 minutes had sensitivity of 77% and specificity of 100% to predict sensory block.

Table 10: Sensitivity and specificity at different perfusion index ratio for predicting sensory block.

Perfusion index ratio	Sensitivity	Specificity
2.2	86%	100%
2.05	93%	66%
1.95	94%	33%
1.85	96%	33%

At the cut-off value of 2.2, perfusion index ratio had sensitivity of 86% and specificity of 100% to predict sensory block.

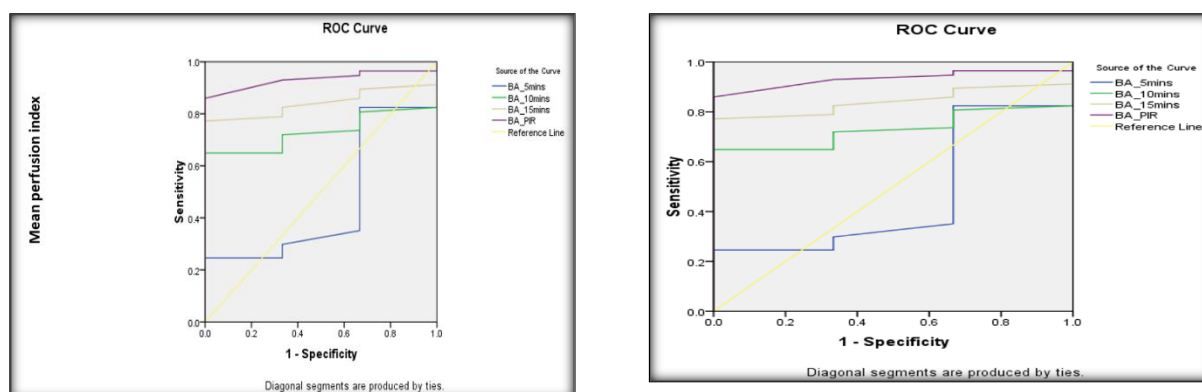


Figure 2: ROC curve to predict sensory block

ROC curve to predict motor block

Area under receiver operator curve (AUROC) for perfusion index at various time intervals and perfusion index for motor block

Perfusion index	AUROC	P value
Perfusion index at 5mins	0.465	0.839
Perfusion index at 10mins	0.731	0.180
Perfusion index at 15mins	0.842	0.047*
PIR	0.933	0.012*

* p value significant

Area under receiver operator curve (AUROC) for perfusion index was 0.84 at 15 minutes.

AUROC for perfusion index ratio was 0.933.

Sensitivity and specificity at different perfusion index values at 15 minutes for predicting motor block.

Perfusion index	Sensitivity	Specificity
6.95	77%	100%
6.75	78%	66%
6.55	80%	66%
6.45	82%	66%
6.3	86%	33%

At the cut-off value of 6.95, perfusion index at 15 minutes had sensitivity of 77% and specificity of 100% to predict motor block.

Sensitivity and specificity at different perfusion index ratio for predicting motor block.

Perfusion index ratio	Sensitivity	Specificity
2.2	86%	100%
2.05	93%	66%
1.95	94%	33%
1.85	96%	33%

At the cut-off value of 2.2, perfusion index ratio had sensitivity of 86% and specificity of 100% to predict motor block.

DISCUSSION

Demographic characteristics: Age: In the present study, mean age of the study participants was 40 years which was higher than the study done by Lal et al.^[16] However in another study by Avci et al mean age of the patients was 43 years.^[17] Another study by Ceylan et al also reported mean age as 42 years.^[18] Studies by Kim et al,^[19] and Raj et al,^[20] reported mean age as 45 years and 33 years respectively.

Sex: In our study, almost 72% of the patients were male. Similarly few other studies done by Lal et al,^[16] Avci et al,^[17] Kim et al,^[19] and Raj et al,^[20] had a predominant male study population.

Body mass index: In our study, mean body mass index (BMI) was 23.1 kg/m² and 23.3% were overweight. Similarly, another study by Kim et al reported average body mass index as 24. Another study by Raj et al,^[20] reported BMI of 23.

ASA status: Majority of patients belonged to ASA PS class II. Whereas few other studies have included higher proportion of patients from ASA PS class 1.^[16,17,19-21]

Mean duration of surgery: Mean duration of surgery was 83 minutes and among majority of patients surgery was performed for 60 to 75 minutes.

Perfusion index: In our study, perfusion index at 5, 10 and 15 minutes was significantly high in blocked arm compared to unblocked arm. At all different

times of measurement, perfusion index was significantly higher than the baseline value in the blocked arm. Similar findings were reported by Avci et al,^[17] Abdelnasser et al,^[22] Raj et al,^[20] and Veena et al.^[21] In this study, a linear increase in perfusion index was noticed in the blocked arm starting from 5 minutes to 15 minutes. Consistent with findings of this study, another study by Avci et al also reported such linear increase in perfusion index over time.^[17] Similarly, Ceylan et al reported an increase in perfusion index after 5 minutes.^[18] Other studies by Raj et al, Sebastiani et al and Tugcugil et al also found similar incremental change in perfusion index in the blocked arm.^[20] In the current study, mean perfusion index ratio in blocked arm was 2.61 and in unblocked arm it was 1.01. The difference was statistically significant. Mean perfusion index ratio in the present study was almost similar to a study by Abdelnasser et al,^[22] where it was 2.5. In their study, Veena et al also reported significantly higher mean Perfusion Index Ratio (PIR) in the blocked arm than unblocked arm.^[21] In our study, sensory block and motor block was successful in 95% of the patients. Success rate of brachial plexus block in the present study was higher than the study by Lal et al,^[16] where it was 92% and Abdelnasser et al,^[22] where it was 91%. There was a significant correlation found between perfusion index ratio and sensory block and motor block.

In our study, Area under receiver operator curve (AUROC) for perfusion index was 0.84 at 15 minutes. However, a study done by Kim et al reported that PI at 5 minutes served as a better predictor of Brachial plexus block. AUROC for perfusion index ratio was 0.933. In our study, at the cut-off value of 6.95, perfusion index at 15 minutes had sensitivity of 77% and specificity of 100% to predict sensory and motor block. Whereas in another study by Lal et al the best cut off for perfusion index to predict successful Brachial plexus block was 3.25.^[16]

In our present study, at the cut-off value of 2.2, perfusion index ratio had sensitivity of 86% and specificity of 100% to predict sensory and motor block. This cut off is lower than the cut off value of 3 reported by Lal et al.^[16] In contrast to this study, Abdelnasser et al reported a very low cut off level of 1.4.^[22]

CONCLUSION

Perfusion index and perfusion index ratio at various time interval of measurement were significantly higher in blocked arm than unblocked arm. Perfusion index increased linearly over time in the blocked arm whereas it was almost constant in the unblocked arm. Perfusion index at 15 minutes with a cut-off 6.95 would be a better predictor to predict the success of supraclavicular brachial plexus block. Perfusion index ratio with a cut off value of 2.2

could be used as a predictor to evaluate the success of supraclavicular brachial plexus block.

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