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Original Research Article

TO PREDICT SUCCESSFUL SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK USING PERFUSION INDEX

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ABSTRACT

Background: Brachial plexus block (BPB) is one of the most commonly used peripheral nerve blocks. The supraclavicular block is considered to be a better approach than performing brachial plexus block at other levels. Brachial plexus block is considered to be an alternateprocedure to general anaesthesia to achieve analgesia of the upper limb. **Objectives:** To study and predict successful ultrasound-guided supraclavicular brachial plexus block using perfusion index. **Materials and Methods:** A prospective observational study was done between February 2023 and February 2024 at Kamineni Institute of Medical Sciences, Narketpally among patients posted for elective upper limb surgeries. Patients those who were aged 18 to 60 years with ASA and Ⅱ were included in the study. The study was conducted after obtaining ethical approval from the institutional ethics committee. Routine pre-anaesthetic checkups, examinations, investigation and preoperative procedures were done. The supraclavicular block was performed in the operating room. The perfusion index was measured at 5, 10 and 15 minutes and the perfusion index ratio was calculated. Appropriate statistical tests were performed.
Results: A total of 99 patients were included in the study with a mean age of 40.57 years and 52.5% were males. The majority of patients belonged to ASA Ⅱ. The perfusion index at 5, 10, and 15 minutes was significantly higher in the blocked arm than in the unblocked arm. A linear increase in perfusion index was noticed in the blocked arm starting from 5 minutes to 15 minutes. The perfusion index ratio was significantly higher in the blocked arm than the unblocked arm. The area under the receiver operatorcurve(AUROC) for PI at 15 minutes was 0.851 and 0.954 for PIR.
Conclusion: Perfusion index at 15 minutes with a cut-off of 6.95 would be a better predictor to predict the success of supraclavicular brachial plexus block. Perfusion indexratio with a cut- off value of 2.2 could be used as a predictor to evaluate the success of the supraclavicular brachial plexus block.
Keywords: Perfusion index, perfusion index ratio, supraclavicular brachial plexus block, sensory, motor.

INTRODUCTION

Brachial plexus block is one of the most commonly used peripheral nerve blocks. Brachial plexus block is most often used during surgeries of the upper limb, orthopaedic manipulation in the upper extremity and also as pain therapy.[1]
Brachial plexus block is considered to be an alternate procedure to general anaesthesia to achieve analgesia of the upper limb. Though brachial plexus block can be performed at various levels including interscalene block, supraclavicular block, infraclavicular block and axillary block, the 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 the supraclavicular level has a low risk of neurological damage, lower rates of semi-diaphragmatic paresis, Horner's syndrome and hoarseness of voice.[4,5,6,7] Many previous studies have shown that the brachial plexus block at the supraclavicular level provides the highest extent of sensory block compared to the brachial plexus block performed at other levels. 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 probes for achieving brachial plexus block is gaining popularity nowadays8.

The major advantage of using an ultrasound-guided procedure is that it produces dense analgesia and anaesthesia with minimal doses of local anaesthetics. The onset of achieving anaesthesia and analgesia is also rapid.[8]

SUPRACLAVICULAR BLOCK: The supraclavicular approach is useful to target trunks and divisions of the brachial plexus The patient has to be placed in supine position with the arms kept by the side, for performing a supraclavicular block. The head of the patient has to be turned away from the side of the block. The ultrasound probe has to be placed in a transverse position above the clavicle. The carotid artery, internal jugular vein and more laterally the subclavian artery are visualised with the help of the probe. Parallel to the probe from lateral to medial direction the needle has to be inserted and the local anaesthetic agent has to be injected around the nerves in the area which is bordered by the subclavian artery, first rib and brachial plexus. Aspiration has to be performed to ensure that there is no blood to avoid intravascular injection of the local anaesthetic agent, during any peripheral nerve block. The occurrence of pneumothorax is one of the most important complications of the supraclavicular approach.

A study by Subramanian et al has reported that compared to the onset of nerve block achieved in other nerves, there was a delay noticed in achieving appropriate nerve block in the ulnar nerve during the supraclavicular block process. This could be probably because the needle tip has not been placed close to the rib to avoid puncturing of pleura in the fear of the occurrence of pneumothorax which results in ulnar nerve sparing.[9]

Peripheral nerve block success is usually assessed using neurological examination by performing sensory and motor test.[10]

However, this neurological assessment has its limitations like the subjective nature of neurological assessment depends on patients' understanding and perception. Cooperation from the patients is also needed 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 who are under general anaesthesia and those who are not able to give feedback on perception.[11]

An accurate and reliable method for assessment of nerve block is essential since early detection of the 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 the blockade of sympathetic nerve fibres and cause a few physiological changes including vasodilatation, an increase in blood flow in the area and an increase in temperature.[12]

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 monitored, skin electrical resistance, tissue oxygen saturation, laser doppler perfusion imaging and perfusion index.[13,14,15,16]

Of the above-mentioned techniques for detection of the success of nerve blockade, the perfusion index is a simple, non-invasive and easy method that would aid in the rapid interpretation of a successful block. Hence the present study was done to identify the ability of the perfusion index in predicting the success of supraclavicular brachial plexus block.

AIMS AND OBJECTIVES OF THE STUDY

To study and predict successful ultrasound-guided supraclavicular brachial plexus block using perfusion index.

PERIPHERALNERVE BLOCK

Regional anaesthesia provides a higher degree of postoperative analgesia, reduced intensity of pain, and lower rates of postoperative nausea and vomiting and when compared withgeneralanaesthesia(GA), italsohashigherratesofpatientsatisfaction.

Peripheralnerves of the upper extremity are superficially located and can be easily identified by linear high- frequency mode ultrasound transducer. Compared to landmark-based approaches, ultrasound (USG) guided peripheral nerve block is advantageous in terms of the lower volume local anaesthetic agent required for achieving successful block.[17]

INDICATIONS FOR PERIPHERAL NERVE BLOCK: Regional blocks are usuallydonetoavoidcomplicationsrelatedtogeneralanaesthesiaforsurgicalproceduresand to avoid side effects related to poly-pharmacy in general anaesthesia18,19,20.

CONTRAINDICATION TO PERFORMPERIPHERAL NERVE BLOCK : Few absolute contraindications where peripheral nerve blocks have to be avoided which include patients who have allergies towards local anaesthetic agents, patients refusal and patients who are not able to co-operate with the procedure. When there is a presence of active infection like cellulitis or abscess at the injection site or there is a presence of pre-existing neurological deficit along the distribution of

the nerve, patients who have coagulopathies or patients on treatment with anticoagulants, it is advisable to postpone or reconsider peripheral nerve block.[17]

TECHNIQUES AND EQUIPMENTS FOR PERFORMINGPERIPHERAL NERVE BLOCKS: For peripheral nerve block multiple techniques can be used and the equipment required depends upon the technique that is used.

ULTRASOUND GUIDANCE FOR PERIPHERAL NERVE BLOCK:

Portable ultrasound machines are available that have high and low-frequency probes that can be used to identify both superficially and deep nerves.

NERVE STIMULATOR GUIDANCE: The peripheral nerve stimulator delivers adjustable electrical current to the tip of a hollow insulated needle which is disposable. The needle that is attached to the peripheral nerve stimulator has specific tubing which attached to a syringe. This allows aspiration and injected of local anaesthetic agent in the injection site. An electrical pulse will be transmitted to the nerve to stimulate it.

CONTINOUS CATHETER: Standard kits are available which contain a needle and a catheter to perform peripheral nerve block.

MATERIALS AND METHODS

Study design: A prospective observational clinical study. In this prospective randomized study, after obtaining approval from the institutional ethics committee and written informed consent from the patient, this study was carried out.

Study Centre: Kamineni Institute of Medical Sciences, Narketpally.

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

Inclusion Criteria

Age between 18 years and 60 years

ASA Physical status 1 and 2.

Patients posted for elective upper limb surgery.

Exclusion Criteria

Patient refusal

H/o allergy to local anaesthetic drugs

Diabetes mellitus

Peripheral vascular disease

Coagulopathy

The Sensitivity (Sn) of the perfusion index was found to be 96.67% from the previously published article. Considering Zα/2 =1.96 at 95% Confidence interval, L=0.05 at 5% precision with 50% prevalence

The Minimum required sample for the total study is 99.

The article considered for the sample size calculation: "A study to evaluate the change in perfusion index as an indicator of successful ultrasound-guided supraclavicular block.

Study duration:February 2023 to February 2024

Study procedure: The study population underwent preanesthetic check-ups 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 ECGs, automated non-invasive blood pressure monitoring, and pulse oximetry. All patients were pre-medicated with Midazolam (0.03mg/kg) and ranitidine 50 mg intravenously. The supraclavicular nerve block was performed under the guidance of a linear transducer over the supraclavicular fossa in the coronal oblique plane immediately superior to the midclavicular point. The block was induced in the 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 (bupivacaine 0.5%, 12.5 ml and lidocaine 2%, 12.5 ml) was injected perineural under vision to surround all the nerve cords.

DATA COLLECTION METHOD

Perfusion index (PI) was measured in both blocked and unblocked arms at Baseline 5 minutes

10 minutes

15 minutes

PERSUION INDEX RATIO (PIR) WAS CALCULATED.

Sensory and motor blocks were assessed for the patients to identify the success of the block. Sensory block was assessed every 3 minutes by pinprick and motor block was assessed every 5 minutes by the ability of the patient to flex the elbow and the hand against resistance.

Ethical approval: Ethical approval for the study was obtained from the Hospital Ethical Committee of Yashoda Hospital. Written informed consent was obtained from all study participants.

Statistical Analysis: The collected data was entered into Microsoft Excel and transferred to SPSS software for analysis. Statistical difference between the two proportions was analysed using the chi-square test. To analyse the difference in mean between 2 groups, an independent t-test was done. The 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. The 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 taken as significant.

RESULTS

The mean age of the study participants was 40.57 years which was ranging between 18 years and 60 years. The majority of the patients were aged between 41 to 50 years.

Table 1: Categorization of patients based on age

Age (Years)	No. of Subjects	Percentage
18 -30	23	23.20%
31 -40	23	23.20%
41 -50	30	30.30%
51 -60	23	23.20%
Total	99	

Table 2: Gender distribution among patients

Sex	No.of Subjects	Percentage
Male	52	52.50%
Female	47	47.50%
Total	99	

Almost 52.5% of the patients were male.

Table 3. Body mass index of patients

BMI	No. of Subjects	Percentage
Healthy Weight	66	66.70%
Over weight or Obese	33	33.30%
Total	99	

Mean body mass index (BMI) was 24.069kg/m233.3% were overweight.

Table 4. Categorisation of patients based on haemoglobin level

Hb	No. of Subjects	Percentage
Anemic	49	49.50%
Non-Anemic	50	50.50%
Total	99	

The mean haemoglobin level was11.944gm/dl, Almost 49.5% had anaemia.

Table 5. Categorization of patients based on ASA grading

ASA	No. of Subjects	Percentage
Grade1	40	40.40%
Grade2	59	59.60%
Total	99	

Majority of patients belonged to ASA classII.

Table 6: Sensory block among patients

Sensory Block	No. of Subjects	Percentage
1	5	5.10%
2	94	94.90%
Total	99	

Table 7: Motor block among patients

MotorBlock	No.ofSubjects	Percentage
0	2	2.00%
1	2	2.00%
2	1	1.00%
3	94	94.90%
Total	99	

Table 8. Adequacy of sensory block among patients

SensoryBlock	No.of Subjects	Percentage
Adequate	94	94.90%
Inadequate	5	5.10%
Total	99	

Sensory block was successful in 94.9% of the patients.

Table 9. Adequacy of motor block among patients

MotorBlock	No.of Subjects	Percentage
Adequate	95	96.00%
Inadequate	4	4.00%
Total	99	

Motor block was successful in 96% of the patients.

Table 10. Duration of surgery

Mean duration of surgery was83.67 minutes with a minimum duration of 60 minutes and a maximum was 115 minutes.

Table 11. Categorisation of patients based on duration of surgery

Duration of Surgery(Mins)	No.of Subjects	Percentage
60 -75	39	39.40%
76 -90	29	29.30%
91 -105	21	21.20%
106-115	10	10.10%
Total	99	

Table 12. Age distribution of patients based on gender

	Sex		
Age (Years)	Male	Female	Total
18 -30	12	11	23
31 -40	11	12	23
41 -50	17	13	30
51 -60	12	11	23
Total	52	47	99
PValue	0.107		
(Chi-SquareTest)			

Majority ofthe female patients were aged between 41-50 years and the majority of the male patients were aged between 41-50 years.

Table 13. Baseline Heart Rate based on ASA category of the patient

ASA	Heart Rate		P Value (t- test)
	Mean	Std. Deviation	
Grade1	81.95	8.709	0.012
Grade2	77.61	7.965	

Mean Heart Rate at baseline was79.36 perminute. None of the patients had bradycardia or tachycardia.

Table 14. Baseline systolic blood pressure based on ASA category of the patient

	Systolic Blood Pressure		PValue(t- test)
ASA	Mean	Std. Deviation	
Grade1	115.5	11.082	
Grade2	115.25	10.398	

Meansystolicbloodpressurewas115.35mmHg.

Table 15. Baseline diastolic blood pressure based on ASAcategory of the patient

	DiastolicBloodPressure		PVale (t-test)
ASA	Mean	Std. Deviation	
Grade1	73	8.228	
Grade2	74.07	7.455	

Mean diastolic blood pressure was 73.64 mmHg. None of the patients had hypertension or hypotension.

Table 16. Baseline mean arterial pressure based on ASA category of the patient

ASA	Mean Arterial Pressure		PValue(t- test)
	Mean	Std. Deviation	
Grade1	87.20	7.845	0.687
Grade2	87.80	6.749	

Table 17. Perfusion index in blocked and unblocked arms

Perfusion Index	Blocked Arm	UnblockedArm	PValue (t-test)
Baseline	2.96±0.837	3.03±0.87	0.027

5Mins	4.21±1.141	3.08±0.882	<0.001
10Mins	7.67±2.135	3.13±0.857	<0.001
15Mins	9.16±2.474	3.18±0.891	<0.001

p-value not significant

There was no significant difference in baseline perfusion index between blocked and unblocked arms.

The perfusion index at 5 minutes in the blocked arm was 4.21±1.141and in the unblocked arm, it was 3.08 ± 0.882. The difference was statistically significant.

The perfusion index at 10 minutes in the blocked arm was7.67±2.135and in the unblocked arm, it was 3.13 ± 0.857. The difference was statistically significant.

The perfusion index at15 minutes in the blocked arm was 9.16±2.474and in the unblocked arm, it was 3.18 ± 0.891. The difference was statistically significant.

Table 18. Perfusion index ratioin blocked and unblocked arms

Perfusion Index Ratio	Mean	Std. Deviation	P value (T Test)
Blocked Arm	2.62	0.507	
UnblockedArm	1	0	

p-value significant

Perfusion index ratio in the blocked arm was 2.62 and in the unblocked arm, it was 1.00. The difference was statistically significant.

Table 19. Association between haemoglobin and perfusion index ratio

Hb	Perfusion Index Ratio Blocked Arm		Value(t- test)
	Mean	Std. Deviation	
Anemic	2.66	0.558	
Non-Anemic	2.59	0.455	0.476

***p-value not significant.**

There was no significant association between haemoglobin level and perfusion index ratio.

Table 20. Association between body mass index and perfusion index ratio

BMI	Perfusion Index Ratio Blocked Arm		PValue (t-test)
	Mean	Std. Deviation	
Healthy Weight	2.66	0.483	
Overweight or Obese	2.56	0.554	

***p value not significant**

There was no significant association between body mass index and perfusion index ratio.

Table 20. Association between body mass index and perfusion index ratio

Perfusion Index		Sensory Block
Baseline	Pearson Correlation	-,001
	Sig (2-tailed)	,995
	N	99
5mins	Pearson Correlation	-,019
	Sig (2-tailed)	,854
	N	99
10mins	Pearson Correlation	203
	Sig (2-tailed)	,044
	N	99
15mins	Pearson Correlation	251
	Sig (2-tailed)	,012
	N	99
Ratio	Pearson Correlation	313
	Sig (2-tailed)	,002
	N	99

With the Pearson correlation test, there was a significant correlation found between the perfusion index ratio and sensory block.

Table 21. Correlation between perfusion index, its ratio and motor block in blocked arm Blocked Arm

Perfusion Index		Sensory Block
Baseline	Pearson Correlation	-,006
	Sig (2-tailed)	,950
	N	99
5mins	Pearson Correlation	-,056
	Sig (2-tailed)	,582
	N	99
10mins	Pearson Correlation	188
	Sig (2-tailed)	,063

	N	99
15mins	Pearson Correlation	233
	Sig (2-tailed)	,020
	N	99
Ratio	Pearson Correlation	,297
	Sig (2-tailed)	,003
	N	99

There was no significant correlation between perfusion index and motor block at 5 minutes, 10 minutes, 15 minutes.

With the Pearson correlation test, there was a significant correlation found between the perfusion index ratio and motor block.

Table 22. Change in perfusion index overtime in the blocked arm

Time Point	Perfusion Index Blocked Arm		P Value (ANOVA)
	Mean	Std. Deviation	
Baseline	2.96	0.837	<0.01
5Mins	4.21	1.141	
10Mins	7.67	2.135	
15Mins	9.16	2.474	

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

Table 23. Area under receiver operator curve (AUROC)and sensitivity, specifictyfor perfusion index at various time intervals

Area Under the Curve								
Perfusion Index Blocked Arm				95% Confidence				
	Area	Std.Error	AsymptoticSig.b	Lower Bound	Upper Bound	Cut off	Sensitivity	Specificity
Baseline	0.512	0.092	0.93	0.332	0.692	3.45	29.80%	100.00%
5 Mins	0.419	0.104	0.544	0.215	0.624	4.85	26.60%	100.00%
10 Mins	0.762	0.047	0.049	0.67	0.854	6.3	71.30%	100.00%
15 Mins	0.851	0.038	0.008	0.776	0.926	6.95	79.80%	100.00%
Ratio	0.954	0.022	0.001	0.911	0.998	2.2	87.20%	100.00%

DISCUSSION

In the present study, the mean age of the study participants was 40.57 years which was higher than the study done by Lal et al,[44] However in another study by Avci et al mean age of the patients was 43 years.[45] Another study by Ceylan et al also reported the mean age as 42 years.46Studies by Kim et al,[47]and Raj et al,[48] reported the mean age as 45 years and 33 years respectively.

In our study, almost 52.5% of the patients were male. Similarly, few other studies done by Lal et al,[44] Avci et al,[45] Kim et al,[47] and Rajet al 48 had a predominantly male study population.

In the current study, the mean body mass index (BMI) was 24.069 kg/m2 and 33.3% wereoverweight. Similarly, another study by Kim et al reported the average body mass index as 2447. Another study by Raj et al48 reported a BMI of 23.

In the current study, the mean haemoglobin level was11.944 gm/dl; Almost 49.5% had anaemia. In another study by Veena et al, the mean haemoglobin level was 10.7gm%.[50]

The majority of patients belonged to ASA class II.Where as few other studies have included a higher proportion of patients from ASA classI.[44,46,47,48,49]

The mean duration of surgery was 83.67 minutes and among the majority of patients surgery was performed for 60 to 75 minutes.

The mean heart rate at baseline was79.36 per minute. None of the patients had bradycardia or tachycardia. The mean systolic blood pressure was 115.35 mmHg. The mean diastolic blood pressure was 73.64 mmHg. None of the patients had hypertension or hypotension.

In this study, the perfusion index at 5,10 and 15 minutes was significantly higher in the blocked arm compared to the unblocked arm. In the present study, at all different times of measurement, the perfusion index was significantly higher than the baseline value in the blocked arm. Similar findings were reported by Avcietal,[45] Abdelnasser et al,[39] Raj et al,[48] and Veena et al.[50]

In this study, a linear increase in perfusion index was noticed in the blocked arm starting from 5 minutes to 15 minutes. Consistent with the findings of this study, another study by Avci et al also reported such a linear increase in perfusion index over time.45 Similarly, Ceylan et al reported an increase in perfusion index after 5 minutes.[46] Other studies by Raj et al, Sebastiani et al and Tugcugil et al also found a similar incremental change in the perfusion index in the blocked arm.[48,42,51]

In the current study, the mean perfusion index ratio in the blocked arm was 2.62 and in the unblocked arm, it was 1.00. The difference was statistically significant.

The mean perfusion index ratio in the present study was almost similar to a study by Abdelnasser et al,[39] where it was 2.5. In their study, Veena et al also reported a significantly higher mean Perfusion Index Ratio(PIR) in the blocked arm than the unblocked arm.[50]

There was no significant association between haemoglobin level, body mass index and perfusion index ratio. In our study, sensory block was successful in 94.9%and motor block was successful in 96% of the patients. The success rate of the brachial plexus block in the present study was higher than the study by Lal et al,[44] where it was 92% and Abdelnasser et al,[39] where it was 91%.

With the Pearson correlation test, there was a significant correlation found between the perfusion index ratio and sensory block. With the Pearson correlation test, there was a significant correlation found between the perfusion index ratio and motor block. In the present study, the Area under the receiver operator curve (AUROC) for perfusion index was 0.851at15 minutes. However, a study done by Kim et al reported that PI at 5 minutes served as a better predictor of Brachial plexusblock.[47] AUROC for perfusion index ratio was 0.954.

In the present study, at the cut-off value of6.95, the perfusion index at15 minutes h7 had a sensitivity of 79.8% 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 topredict a successful Brachial plexus block was 3.25.[44]

In the present study, at the cut-off value of 2.2, the perfusion index ratio had a sensitivity of 87.2% 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,[44] In contrast to this study, Abdelnasser et al reported a very low cut-off level of 1.4.[39]

CONCLUSION

The perfusion index and perfusion index ratio at various time intervals of measurement were significantly higher in the blocked arm than in the unblocked arm. Perfusion index increased linearly overtime in the blocked arm where as 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 the supraclavicular brachial plexus block.

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