

# Evaluation of perfusion index as an objective indicator of successful interscalene block



Pardeep Kumar<sup>1</sup>, Vandna Arora<sup>2</sup>, Akanksha Khatri<sup>3</sup>, Suresh Kumar Singhal<sup>4</sup>, Shikha Madan<sup>5</sup>

<sup>1,2</sup>Assistant Professor, <sup>3</sup>Senior Resident, <sup>4</sup>Senior Professor and Head, Department of Anaesthesiology, <sup>5</sup>Associate Professor, Department of Obstetrics and Gynaecology, Pandit Bhagwat Dayal Sharma Post Graduate Institute of Medical Sciences, Rohtak, Haryana, India

Submission: 27-11-2022

Revision: 31-12-2022

Publication: 01-02-2023

## ABSTRACT

**Background:** Interscalene nerve blocks are commonly performed for surgeries of the upper limb. Assessment methods for evaluation of blocks are conventional and subjective. **Aims and Objectives:** The aim of the study was to evaluate perfusion index (PI) as an objective indicator for assessing successful ultrasound guided interscalene block. **Materials and Methods:** This prospective, observational study included adult patients undergoing upper limb surgery (humerus and shoulder) under USG guided interscalene nerve block. PI was recorded at baseline (before LA administration), at every 2 min till 10 min, and then every 5 min till 30 min after the block in both the arms. The PI values were compared between the blocked and unblocked arms at all observed time points. PI ratio was calculated as the ratio between PI at 15 min after block and the baseline PI. **Results:** The PI increased significantly in the blocked limb after local anesthetic injection and there was a statistically significant difference in PI values between the blocked and unblocked arms at all-time points. Both PI and PI ratio at 15 min after injection showed a sensitivity and specificity of 100% for block success at cutoff values of 3.2 and 2.04, respectively. **Conclusion:** PI maybe used as an objective indicator of successful interscalene nerve block. PI > 3.2 and PI ratio > 2.04 at 15 min are accurate predictors for block success.

**Key words:** Perfusion index; Interscalene; Nerve block; Ultrasound

### Access this article online

**Website:**

<http://nepjol.info/index.php/AJMS>

**DOI:** 10.3126/ajms.v14i2.49867

**E-ISSN:** 2091-0576

**P-ISSN:** 2467-9100

Copyright (c) 2023 Asian Journal of Medical Sciences



This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

## INTRODUCTION

Interscalene nerve block is typically performed to provide anesthesia or analgesia for surgery of the shoulder and upper arm. The improved safety afforded by ultrasound in localizing the plexus and in particular the visualization of pleura and needle position has been the turning point in the increased use of peripheral nerve blocks.<sup>1</sup> The success of peripheral nerve blocks is usually assessed by sensory and motor function, however this method is subjective, requires patient co-operation and cannot be done in patients under GA, deep sedation or otherwise unable to provide feedback. Various objective methods such as thermographic temperature measurement,<sup>2</sup> laser Doppler perfusion imaging,<sup>3</sup> and skin electrical resistance<sup>4</sup> also have been developed, which depends on evaluation of sympathetic block and consequent physiological

changes such as vasodilation, change in blood flow and skin temperature. However, most of these objective methods are either time consuming or dependent on sophisticated equipment.<sup>5</sup> Perfusion index (PI) is a new simple and objective method for evaluation of the success of peripheral nerve blocks. Few studies have documented that it is a good predictor for block success and can be used as an alternative for sensory or motor function tests.<sup>5-7</sup>

Therefore, the present study aimed to evaluate PI as an objective indicator for assessing successful ultrasound guided interscalene block. The objectives of the study were to observe the change in PI values before and after interscalene block in the blocked and unblocked arms and to calculate cutoff values of PI and PI ratio as predictors of successful block.

### Address for Correspondence:

Dr. Vandna Arora, Assistant Professor, Department of Anaesthesiology, Pandit Bhagwat Dayal Sharma Post Graduate Institute of Medical Sciences, Rohtak - 124 001, Haryana, India. **Mobile:** +91-8750286684. **E-mail:** drvandna4@gmail.com

## Aims and objectives

The aim of the study was to evaluate PI as an objective indicator for assessing successful ultrasound-guided interscalene block.

## MATERIALS AND METHODS

The present prospective and observational study was conducted in the Department of Anaesthesiology and Critical care in a tertiary care institute after Institutional Ethics Committee clearance and informed written consent. Adult patients (18–60 years) of either sex belonging to ASA I-II undergoing upper limb surgery (humerus and shoulder) under USG-guided interscalene nerve block were included in the study. Patients with diabetes mellitus, peripheral vascular disease, allergy to local anesthetics (LAs), and local site infection were excluded from the study.

Patients were kept fasting for 6 h before the scheduled time of surgery. Ultrasound-guided interscalene block was performed in premedication room using Sonosite M-Turbo ultrasound machine with high frequency (10–13 MHz) linear array probe. The block was performed in supine position or slight elevation of the head end of bed, with the patient's head turned away from the side to be blocked. A total volume of 15 ml of LA (10 ml of 0.5% bupivacaine and 5 ml of 2% lignocaine) was injected. PI was measured using Masimo radical-7 SET pulse oximeter applied on middle finger of both arms.<sup>8</sup> PI was recorded at baseline (before LA administration), at every 2 min till 10 min, and then every 5 min till 30 min after the block in both the arms. The PI values were compared between the blocked and unblocked arms at all observed time points. PI ratio was calculated as the ratio between PI at 15 min after block and the baseline PI. The interscalene block was considered effective when a motor block (inability to elevate arm against gravity) and a sensory block (inability to recognize pinprick on skin of the anesthetized arm) developed within 30 min after application of local anesthetics.

After a minimum of 30 min, patients were transferred to operating room. In operation theatre, block was assessed by pinching the surgical area with a plastic clamp. When no sensation was felt at the site of surgical area, block was considered successful. If there was pain at the surgical site, block was considered as failed block, and supplemental analgesia or conversion to GA was considered as per requirement of the patient. We recorded and analyzed the data of the failed block cases also and compared it to those with successful block.

### Sample size

Abdelnasser et al.,<sup>5</sup> reported that mean with PI ratio was 2.5 in blocked arm group and 1 in unblocked arm groups.

For the sample size calculation, we defined mean difference of 1.5 with 1.8 Standard Deviation. At 95% confidence interval, 80% power and alpha level of 0.05, the sample size was taken as 30 including follow-up lost and incomplete data recording.

### Statistical analysis

Descriptive statistics were analyzed with SPSS version IBM manufacturer, Chicago, USA, version 25.0. Categorical variables were expressed as frequencies and percentages while the quantitative data were presented as mean±SD or median. The data normality was checked using Kolmogorov–Smirnov test. Mann–Whitney test and Wilcoxon Signed-Ranks test were used for non-normally distributed quantitative variables. Receiver operating characteristic curve was used to find cutoff value, sensitivity, specificity, positive predictive value, and negative predictive value of PI at 15 min and PI ratio for predicting successful block.  $P < 0.05$  was considered statistically significant.

## RESULTS

A total of 37 patients were enrolled in the study out of which two patients refused consent while failure of block was observed in five patients (Figure 1). Successful block was observed in 30 patients. Demographic characteristics of the subjects enrolled are shown in Table 1.

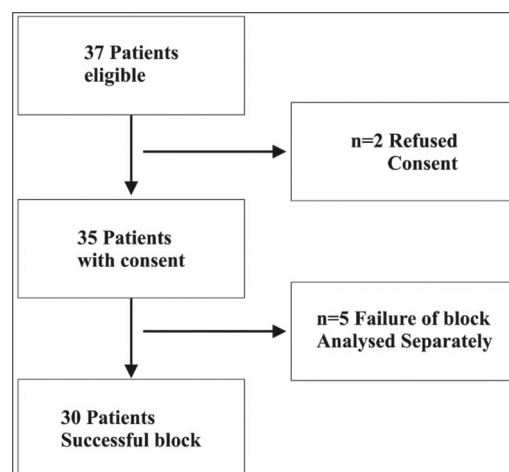


Figure 1: Consort diagram

Table 1: Demographic characteristics of study patients

Characteristic	Values (Mean±SD or n)
Age (years)	30.27±11.1
Male/female (n)	24/6
Weight (kg)	62.73±8.9
Height (cm)	168.83±6.81
ASA I/II (n)	21/9
Duration of surgery (hours)	2.15±0.46

PI values were comparable in blocked and unblocked arms at baseline. In cases of successful block, there was a statistically significant difference in PI values between the blocked and unblocked arms at rest of all the observed time points after the block ( $P < 0.05$ ) (Table 2 and Figure 2). In the blocked arm, PI increased significantly from baseline value within first 2 min after the block and reached maximum value at 15 min after which values either remained similar or slightly decreased for upto 30 min ( $P < 0.05$ ) (Table 2 and Figure 2). No such increase in PI was observed in the unblocked arm ( $P > 0.05$ ).

While in cases of failed blocks, increase in PI after the block was minimal and non-significant from baseline values in the blocked arm (Figure 3).

PI at 15 min and PI ratio predicted block success with cutoff values of  $>3.2$  and  $>2.04$ , respectively (Table 3).

## DISCUSSION

PI is a non-invasive indicator of peripheral perfusion as it is affected by changes in peripheral vascular tone. It is

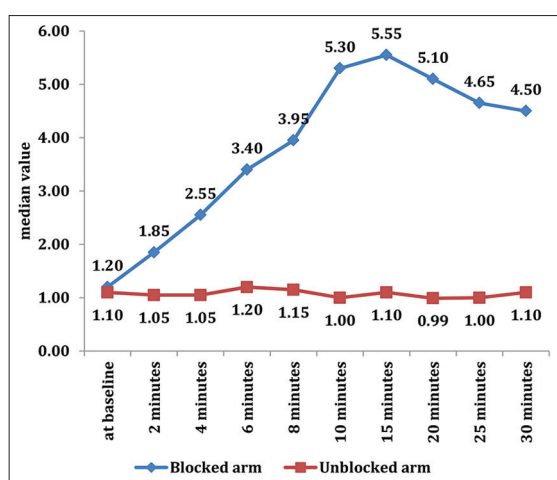
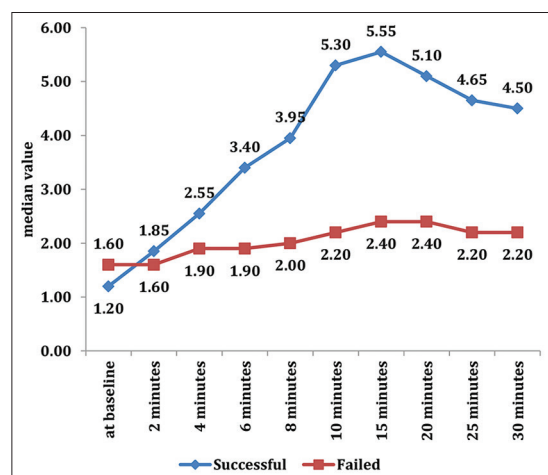
**Table 2: Comparison of perfusion index between blocked and unblocked arm in successful block cases**

Perfusion index	Blocked arm (n=30)	Unblocked arm (n=30)	P-value
At baseline			
Mean±SD	1.24±0.49	1.23±0.48	0.849*
Median (25 <sup>th</sup> –75 <sup>th</sup> percentile)	1.2 (0.915–1.5)	1.1 (0.935–1.6)	
Range	0.2–2.2	0.25–2.2	
2 min			
Mean±SD	2.05±0.7	1.2±0.45	<0.0001*
Median (25 <sup>th</sup> –75 <sup>th</sup> percentile)	1.85 (1.6–2.175)	1.05 (0.928–1.5)	
Range	1.2–4	0.22–2	
Intra group P-value	<0.0001*	0.352*	-
4 min			
Mean±SD	2.74±0.88	1.17±0.46	<0.0001*
Median (25 <sup>th</sup> –75 <sup>th</sup> percentile)	2.55 (2.025–3.3)	1.05 (0.915–1.5)	
Range	1.8–5.4	0.24–2.1	
Intra group P-value	<0.0001*	0.004*	-
6 min			
Mean±SD	3.42±0.91	1.22±0.48	<0.0001*
Median (25 <sup>th</sup> –75 <sup>th</sup> percentile)	3.4 (2.725–3.9)	1.2 (0.913–1.475)	
Range	2–6.1	0.24–2	
Intra group P-value	<0.0001*	0.688*	-
8 min			
Mean±SD	4.04±1.01	1.19±0.42	<0.0001*
Median (25 <sup>th</sup> –75 <sup>th</sup> percentile)	3.95 (3.2–4.725)	1.15 (0.92–1.5)	
Range	2.6–6.6	0.25–2	
Intra group P-value	<0.0001*	0.503*	-
10 min			
Mean±SD	5.47±1.29	1.2±0.47	<0.0001*
Median (25 <sup>th</sup> –75 <sup>th</sup> percentile)	5.3 (4.8–6.15)	1 (0.91–1.8)	
Range	3.3–8.4	0.28–1.9	
Intra group P-value	<0.0001*	0.293*	-
15 min			
Mean±SD	5.75±1.28	1.26±0.51	<0.0001*
Median (25 <sup>th</sup> –75 <sup>th</sup> percentile)	5.55 (5–6.5)	1.1 (0.92–1.9)	
Range	3.3–8.6	0.27–2	
Intra group P-value	<0.0001*	0.303*	-
20 min			
Mean±SD	5.27±1.25	1.24±0.53	<0.0001*
Median (25 <sup>th</sup> –75 <sup>th</sup> percentile)	5.1 (4.5–6.175)	0.99 (0.958–1.7)	
Range	3.2–7.8	0.25–2.1	
Intra group P-value	<0.0001*	0.657*	-
25 min			
Mean±SD	5.01±1.24	1.18±0.47	<0.0001*
Median (25 <sup>th</sup> –75 <sup>th</sup> percentile)	4.65 (4.125–6)	1 (0.92–1.4)	
Range	3–7.5	0.25–2.4	
Intra group P-value	<0.0001*	0.296*	-
30 min			
Mean±SD	4.89±1.22	1.24±0.5	<0.0001*
Median (25 <sup>th</sup> –75 <sup>th</sup> percentile)	4.5 (4–5.975)	1.1 (0.918–1.575)	
Range	2.8–7.2	0.22–2.2	
Intra group P-value	<0.0001*	0.931*	-

\*  $p < 0.05$  = significant

**Table 3: Receiver operating characteristic curve of Perfusion index at 15 min and Perfusion index ratio for predicting successful block**

Variables	Perfusion index at 15 min	Perfusion index ratio
Area under the ROC curve (AUC)	1	1
Standard error	0	0
95% confidence interval	0.900–1.000	0.900–1.000
P-value	<0.0001	<0.0001
Cut off	>3.2	>2.0408
Sensitivity (95% CI)	100 (88.4–100.0)	100 (88.4–100.0)
Specificity (95% CI)	100 (47.8–100.0)	100 (47.8–100.0)
PPV (95% CI)	100 (88.4–100.0)	100 (88.4–100.0)
NPV (95% CI)	100 (47.8–100.0)	100 (47.8–100.0)
Diagnostic accuracy (%)	100.00	97.14

**Figure 2:** Comparison of perfusion index at different time intervals between blocked and unblocked arm**Figure 3:** Comparison of perfusion index at different time intervals between successful and failed block

obtained by calculating the ratio of a pulsating signal (AC) to a non-pulsating signal (DC). PI has been investigated for evaluation of different conditions comprising of vasodilatation, such as induction of anaesthesia,<sup>9</sup> epidural block,<sup>10</sup> stellate ganglion block,<sup>11</sup> and successful thoracic sympathectomy.<sup>12</sup> Furthermore, it has been advocated as an

early predictor of block success.<sup>5,7,13,14</sup> A successful brachial plexus block causes sympathetic blockade and consecutive vasodilatation leading to an increase in the PI.<sup>5,6</sup> The present study was planned to evaluate the change in PI as an indicator of successful interscalene block.

We observed that PI values in blocked arm increased significantly within 2 min of interscalene local anesthetic injection in cases of successful block. PI values increased up to 15 min and then only slightly decreased till 30 min.

Similar results were observed in previous studies. Sebastiani et al., conducted a study in 30 patients undergoing elective orthopedic surgery with USG-guided ISB and recorded PI at baseline and 5, 10, and 15 min after the block. They observed progressive increase in PI from baseline (0.2) up to 15 min (2.2) in the blocked arm.<sup>6</sup> Abdelnasser et al., conducted a study in 77 patients undergoing upper limb surgery under USG guided supraclavicular block and measured PI at baseline and 10, 20, and 30 min after the block in both blocked and unblocked arms. They found persistent increase in mean PI from baseline (2.8) up to 30 min (7.1) in blocked arm.<sup>5</sup> Kus et al., conducted a study in patients undergoing upper limb surgery under USG-guided infraclavicular block and observed that PI values increased significantly from baseline during 30 min observation period in case of successful blocks unlike failed blocks where no such increase in PI was noted.<sup>7</sup> Raj and Kingslin conducted a study in 32 patients undergoing hand, wrist, forearm surgery under USG-guided supraclavicular block and observed continuous increase in mean PI values from baseline for up to 20 min in blocked arm while it did not show any change when compared to baseline in the unblocked arm.<sup>13</sup>

In our study, the baseline values of PI were comparable between successful and failed blocks. Unlike successful blocks, PI increased minimally from 2 min to 30 min in case of failed blocks. Comparing the data between successful and failed blocks, we calculated cutoff values for PI at 15 min and PI ratio to predict successful interscalene block as there is a high variability in baseline PI values amongst individuals.<sup>15</sup>

Our results are consistent with a previous study done by Abdelnasser et al., in which the authors calculated cutoff values for prediction of successful supraclavicular block.<sup>5</sup> The slight difference in cutoff values of PI ratio between the two studies may be due to the difference in the block site.

### Limitations of our study

The present study had a small sample size with fewer number of failed blocks which may have affected the cutoff values. Further studies with large sample sizes are required to establish standard cutoff values of PI and PI ratio to predict successful blocks.

## CONCLUSION

PI increases after successful block and can be used as an objective indicator of successful interscalene nerve block. PI >3.2 and PI ratio >2.04 at 15 min are accurate predictors for block success.

## ACKNOWLEDGMENT

Nil.

## REFERENCES

- Raju BC, Pavan K and Coventry DM. Ultrasound-guided brachial plexus blocks. *Contin Educ Anaesth Crit Care Pain*. 2014;14:185-191.  
<https://doi.org/10.1093/bjaceaccp/mkt059>
- Minville V, Gendre A, Hirsch J, Silva S, Bourdet B, Barbero C, et al. The efficacy of skin temperature for block assessment after infraclavicular brachial plexus block. *Anesth Analg* 2009;108(3):1034-1036.  
<https://doi.org/10.1213/ane.0b013e318195bf94>
- Sørensen J, Bengtsson M, Malmqvist EL, Nilsson G and Sjöberg F. Laser doppler perfusion imager (LDPI)--for the assessment of skin blood flow changes following sympathetic blocks. *Acta Anaesthesiol Scand*. 1996;40(9):1145-1148.  
<https://doi.org/10.1111/j.1399-6576.1996.tb05578.x>
- Smith GB, Wilson GR, Curry CH, May SN, Arthurson GM, Robinson DA, et al. Predicting successful brachial plexus block using changes in skin electrical resistance. *Br J Anaesth*. 1988;60(6):703-708.  
<https://doi.org/10.1093/bja/60.6.703>
- Abdelnasser A, Abdelhamid B, Elsonbaty A, Hasanin A and Rady A. Predicting successful supraclavicular brachial plexus block using pulse oximeter perfusion index. *Br J Anaesth*. 2017;119(2):276-280.  
<http://dx.doi.org/10.1093/bja/aex166>
- Sebastiani A, Philippi L, Boehme S, Closhen D, Schmidtman I, Scherhag A et al. Perfusion index and plethysmographic variability index in patients with interscalene nerve catheters. *Can J Anaesth*. 2012;59(12):1095-1101.  
<https://doi.org/10.1007/s12630-012-9796-3>
- Kus A, Gurkan Y, Gormus SK, Solak M and Tokar K. Usefulness of perfusion index to detect the effect of brachial plexus block. *J Clin Monit Comput*. 2013;27(3):325-328.  
<https://doi.org/10.1007/s10877-013-9439-4>
- Masimo Corporation. Masimo Rainbow SET ® Rad-57 Pulse CO-oximeter and Accessories. Available from: [https://www.accessdata.fda.gov/cdrh\\_docs/pdf8/K080238.pdf](https://www.accessdata.fda.gov/cdrh_docs/pdf8/K080238.pdf). [Last accessed on 2021 Sep 21].
- Park SG, Lee OH, Park YH, Shin HY, Kang H, Baek CW, et al. The changes of non-invasive hemoglobin and perfusion index of pulse co-oximetry during induction of general anesthesia. *Korean J Anesthesiol*. 2015;68(4):352-357.  
<https://doi.org/10.4097/kjae.2015.68.4.352>
- Ginosa R, Weiniger CF, Meroz Y, Kurz V, Bdolah-Abram T, Babchenko A, et al. Pulse oximeter perfusion index as an early indicator of sympathectomy after epidural anesthesia. *Acta Anaesthesiol Scand*. 2009;53(8):1018-1026.  
<https://doi.org/10.1111/j.1399-6576.2009.01968.x>
- Yamazaki H, Nishiyama J and Suzuki T. Use of perfusion index from pulse oximetry to determine efficacy of stellate ganglion block. *Local Reg Anesth* 2012;5:9-14.  
<https://doi.org/10.2147/LRA.S30257>
- Klodell CT, Lobato EB, Willert JL and Gravenstein N. Oximetry-derived perfusion index for intraoperative identification of successful thoracic sympathectomy. *Ann Thorac Surg*. 2005;80(2):467-470.  
<https://doi.org/10.1016/j.athoracsur.2005.02.075>
- Raj RL and Kingslin A. Prediction of successful supraclavicular brachial plexus block using pulse oximeter perfusion index. *Glob J Res Anal*. 2019;8:30-32.  
<https://doi.org/10.1093/bja/aex166>
- Avci O and Gündoğdu O. Evaluation of ultrasound guided supraclavicular block with traditional methods and perfusion index on upper extremity surgeries. *Van Tip Derg*. 2020;27(1):38-44.  
<https://doi.org/10.5505/vtd.2020.15679>
- Lima AP, Beelen P and Bakker J. Use of a peripheral perfusion index derived from the pulse oximetry signal as a noninvasive indicator of perfusion. *Crit Care Med*. 2002;30(6):1210-1213.  
<https://doi.org/10.1097/00003246-200206000-00006>

#### Authors' Contributions:

**PK, VA** - Concept and design of the study, prepared first draft of manuscript, and interpreted the results; **AK** - Reviewed the literature and manuscript preparation; **SSK** - Concept, coordination, statistical analysis, and interpretation; **SM** - Preparation of manuscript and revision of the manuscript.

#### Work attributed to:

Pt. B.D. Sharma PGIMS, Rohtak - 124 001, Haryana, India.

#### Orcid ID:

Dr. Pardeep Kumar - <https://orcid.org/0000-0002-6025-434X>  
 Dr. Vandna Arora - <https://orcid.org/0000-0002-8179-8442>  
 Dr. Akanksha Khatri - <https://orcid.org/0000-0001-9863-8333>  
 Dr. Suresh Kumar Singhal - <https://orcid.org/0000-0002-8993-9924>  
 Dr. Shikha Madan - <https://orcid.org/0000-0001-5206-6827>

**Source of Funding:** Nil, **Conflicts of Interest:** None declared.