Original Article

Are The Perfusion İndex And Pleth Variability Index Title an Early İndicator of Brachial Plexus Block?

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Abstract

Background: Studies on the evaluation of the Perfusion Index (PI) and the Pleth Variability Index (PVI) and the success of PI and PVI block in patients undergoing brachial plexus are limited and quite inadequate. **Aim:** In our study, we aimed to compare PI and PVI between the interscalen block and infraclavicular block and evaluate its use as an early marker in block success. **Patients and Methods:** Single-center prospective randomized controlled trials. Preoperative unit, operating room. Patients over 18 years of age who have had upper extremity surgery. Brachial plexus block (interscalene, infraclavicular). Demographic data, Hemodynamic parameters, Perfusion index and Pleth Variability Index. 40 patients, including ASA1-2, 20 patients over the age of 18, who were planned for upper extremity surgery, in the interscalen group, and 20 in the supraclavicular group, were included in the study. Demographic data of the patients were recorded by measuring PI and PVI values at baseline before the block and at the 1st, 5th, 10th, 15th, and 20th minutes after the block, both simultaneously. **Results:** 62.5% (n = 25) of the patients included in the study were female. The mean age of the patients was detected as 52.63 ± 16.472, the mean BMI as 26.57 ± 4.423, and the mean entry hemoglobin level as 13.71 ± 1.87 g/dL. The hemodynamic data of the groups were similar across the time periods. The increase in PI increased significantly after 1 minute in both groups. The PVI was similar between the groups at all measurement times. **Conclusion:** In our study, we observed an increase in PI from the 1st minute compared to the non-blocked arm in successful block applications. We consider the early indicator of PI in the evaluation of block success. In our study, we did not observe a significant change in the arm that was blocked and the arm that was not treated with PVI.

Keywords: *Infraclavicular block, interscalene block, perfusion index, pleth variability index*

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Introduction

Today, the use of regional anesthesia in practice, especially orthopedic interventions and postoperative analgesia, is quite common. With the widespread use of ultrasonography (USG), visualization of the anatomical structure of the area to be blocked and the use of lower doses of anesthetic agents have reduced complications such as nerve damage and enabled faster and more successful blockade.

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It occurs in the sympathetic block as well as somatic and motor block in a successful block.[1,2] Vasodilation due to sympathetic blockade causes an increase in regional blood flow. In recent years; The view that this regional increase in arterial blood flow can be used as an objective and rapid

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indicator of a successful block has become widespread.[3] Perfusion index is a non-invasive and rapid method for the evaluation of blood flow. By definition, the perfusion index (PI) is the ratio of pulsatile to nonpulsative flow. The normal value range is between 0.02 and 20. Basically, it is an indicator of vasomotor tone.

The Pleth Variability Index (PVI) is a non-invasive oximetric indicator of the variability in PI that occurs throughout the respiratory period. In recent years, it is thought that it can be used as an alternative to invasive methods such as central venous catheterization for measuring vascular tone and intravascular fluid deficit.[4,5] In addition, we think that it can be used as an indicator of block success since it reflects PI variability.

The studies on the evaluation of PI and PVI in patients with brachial plexus and the evaluation of the success of PI and PVI block were limited and quite inadequate. In this study, we aimed to compare PI and PVI between interscalen block and infraclavicular block and evaluate its use as an early marker.

Materials-Methods

Our study, which was designed as a prospective clinical study, was initiated in accordance with the Helsinki declaration and according to the consort flow diagram, after the approval of the clinical research ethics committee of Malatya Turgut Özal University, dated 03.08.2021 and numbered 2021/43. (Clinical Trials.gov ID: NCT05208632) The patients were randomly divided into two groups as the patients who underwent interscalene block (ISB) and infraclavicular block (ICB) by the closed-envelope method by a blinded nurse who did not participate in the study. Based on similar studies, the sample size of the study was calculated as 0.05 patients with alpha and 0.8 patients with a beta, 20 patients in each group, a total of 40 patients.[6] 46 patients over the age of 18 with ASA classification (American Society of Anesthesiologists) I-II, who were planned to undergo upper extremity surgery, were included in the study. Six patients were excluded from the study because they were switched to general anesthesia, and 40 patients who developed successful block were included in the study. Pediatric patients, pregnant patients, patients with peripheral arterial disease, heart failure with a hemoglobin level of 10, renal failure, liver failure, coagulation disorder with neuropathy, and patients with known allergy to local anesthetics were excluded from the study. Wet signed informed consent was obtained from all patients. The flow diagram of the study is given in Figure 1.

All patients included in the study were examined by an anesthesiologist before anesthesia. Following the appropriate fasting period, the patients were taken to the preparation room and routine monitoring (peripheral oxygen saturation, non-invasive arterial measurement of blood pressure, and electrocardiogram) were performed. Vascular access was established with a 20G branule in the other arm, which did not undergo surgery. The patients were administered midazolam (0.05-0.1 mg/kg, Dormicum 5 mg/5 cc, Deva İlaç, Istanbul) for sedation before the procedure. Nasal oxygen was given at 2-4 L/min. In addition to routine monitoring, both upper extremities Perfusion index: PI, Plethysmographic variability index: PVI, hemoglobin HGB, (The probe of a MasimoRadical 7, MasimoCorp. Irvine, CA, USA) were performed. Using an insulated neurostimulation needle (22 G, 50 mm Locoplex, Vygon®, France) accompanied by USG (Samsung HM70 Evo, South Korea) and nerve stimulator (Stimuplex, HNS 11; Braun Melsunçgen, Melsungen, Germany) Interscalen block was performed in 20 patients and the infraclavicular block were performed in 20 patients. After turning the head to the opposite side of the patients in the interscalen group, a skin asepsis was provided with povidone-iodine in the treatment area. The USG probe was placed transversely obliquely from the level of the cricoid cartilage (C6) to the line connecting the interscalene space. The brachial plexus was found and 22G 50 mm insulated nerve stimulator needle was inserted in-plain with a posterior approach and 10 mL of 0.5% bupivacaine, 10 mL of 2% lidocaine, 10 mL of 2% prilocaine were injected considering the loss of response at currents less than 0.2-0.3 mA to avoid the risk of intraneural injection after a distal motor response was found at <0.5 mA with a nerve stimulator. In the infraclavicular group, after the area was cleaned with povidone-iodine, the USG probe was placed in the area where the clavicle and the cricoid process intersect, and the anatomical structure was observed. A 22G 50 mm stimulator needle was inserted with the in-plain approach, and after the distal motor response was found at <0.5 mA with the nerve stimulator, to avoid the risk of intraneural injection, considering the loss of response at currents less than 0.2-0.3 mA, 10 mL% 0.5 bupivacaine, 10 ml 2% lidocaine, 10 ml 2% prilocaine injections were administered. The development of sensorineural block (inability to identify the cold application) in the motor block and related dermatomes was accepted as a successful block.

Demographic data such as age, gender, height, weight, and body mass index (BMI) of the patients and entry hemoglobin levels were recorded. Heart rate (HR) per minute systolic blood pressure (SAP) diastolic blood pressure (DAP) peripheral oxygen saturation (SpO_2) and simultaneous block and contralateral Perfusion index:

PI, Plethysmographic index of variability: PVI values were recorded by measuring baseline, post-block 1st, 5th, 10th, 15th, and 20th values. After the measurements, the patients with successful block were presented to surgery. Patients without complications after surgery were transferred to the orthopedic surgery service.

Statistical analysis

Data analysis was performed using the IBM SPSS version 20.0 statistical program (Chicago, IL, USA). A value of $P < 0.05$ was considered statistically significant. Skewness and Kurtosis values were used to test the normality of the distribution of the data. The variation of quantitative data with comparisons between blocks and between groups over time was analyzed with Mixed Design ANOVA (Mixed Pattern ANOVA). Bonferroni adjustment was used for confidence interval correction. Repeated measures ANOVA (Two Way) was used for intergroup comparisons on the side of the block. The data of categorical variables were presented for mean ± standard deviation and percentage (%).

Results

A total of 40 patients were included in the study, 20 of whom had were supraclavicular block (ISB) and 20 patients were infraclavicular (ICB). 62.5% (n = 25) of the patients included in the study had female. The mean age of the patients was detected as 52.63 ± 16.472, the mean BMI as 26.57 ± 4.423 and the mean entry hemoglobin level as 13.71 ± 1.87 g/dL. Demographic data are shown in Table 1. No significant difference was found between the groups in the statistical analysis of HR, systolic arterial pressure, diastolic pressure, and peripheral

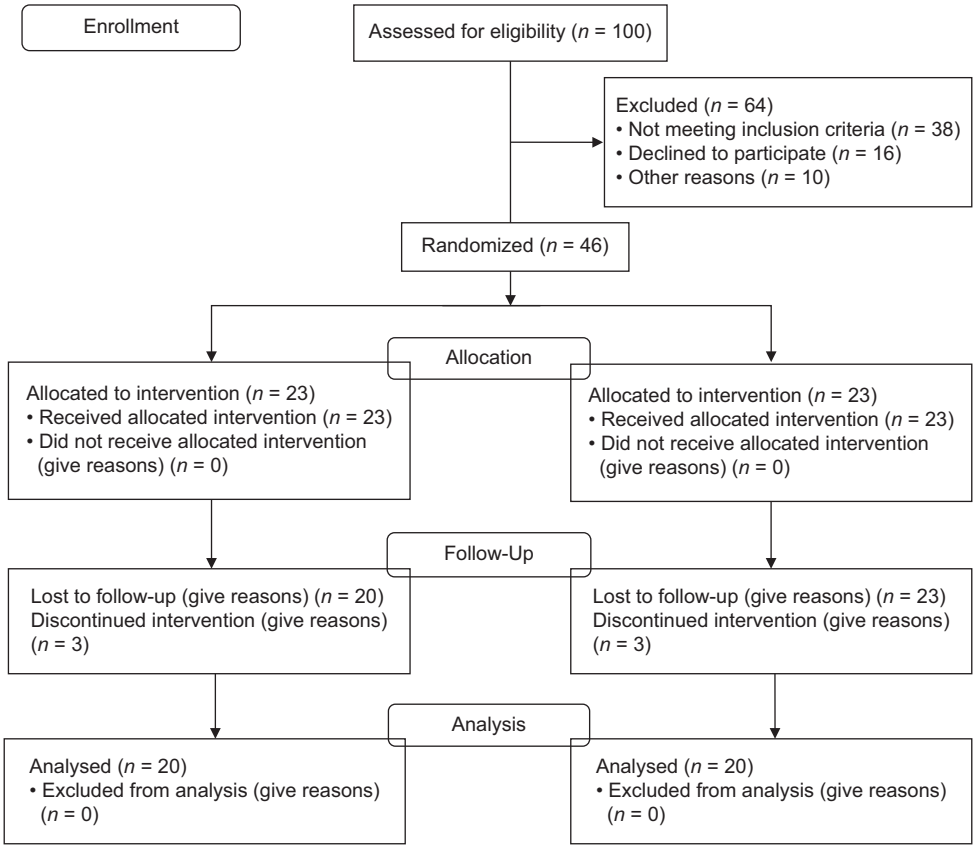

Figure 1: CONSORT 2010 flow diagram

Table 1: Demographic Data

	Interscalene (*n*=20)	Infraclavicular (*n*=20)	Total (*n*=40)
Age (year)	54,40±17,560	50,85±15,554	52,63±16,472
Height (Cm)	162,30±8,603	166,35±6,252	164,33±7,701
Weight (Kg)	72,20±10,943	70,45±9,110	71,33±9,978
BMI	27,622±5,0349	25,518±3,5339	26,5708±4,42374
Hemoglobin (g/dl)	13,7200±1,91959	13,7000±1,87757	13,7100±1,87422
Gender (female, %)	*n*=14, 70%	*n*=11, 55%	*n*=25, 62.5%

Table 2: Analysis of hemodynamic data

	Interscalene Mean±SD. deviation (*n*=20)	Infraclavicular Mean±SD. deviation (*n*=20)	*P*
Hart Rate (HR) beats/minute			
Baseline	78,85±13,339	80,30±17,011	=0,766
1th min.	81,40±8,375	75,90±18,413	=0,037
5th min.	77,45±9,992	75,65±16,490	=0,041
10thmin.	79,70±9,755	73,65±16,426	=0,032
15thmin.	78,60±10,002	73,70±15,808	=0,599
20thmin.	77,05±9,423	71,75±13,984	=0,863
Systalic Blood Pressure (SBP) mmHg			
Baseline	129,90±17,411	126,95±22,282	=0,643
1thmin.	129,90±9,572	119,50±19,814	=0,447
5thmin.	131,05±13,713	119,35±22,229	=0,101
10thmin.	127,65±10,469	117,45±17,908	=0,654
15thmin.	130,00±10,697	121,55±19,449	=0,622
20thmin.	128,90±7,130	124,25±20,284	=0,399
Diastolic Blood Pressure (DBP) mmHg			
Baseline	76,20±9,300	71,30±9,476	=0,107
1thmin.	78,20±8,495	70,65±13,539	=0,502
5thmin.	78,95±11,133	69,95±9,528	=0,656
10thmin.	80,05±6,013	68,80±12,007	=0,439
15thmin.	78,20±6,354	70,55±11,005	=0,172
20thmin.	81,25±6,851	76,05±9,052	=0,499
Peripheral Oxygen Saturation (SpO2)			
Baseline	96,85±1,927	96,60±2,257	=0,017
1thmin.	96,30±1,593	97,70±1,302	=0,017
5thmin.	97,20±0,894	97,60±1,501	=0,025
10thmin.	97,00±1,298	97,55±1,276	=0,688
15thmin.	97,30±1,418	97,30±1,218	=0,082
20thmin.	97,80±1,399	97,50±1,051	=0,489

Table 3: Comparison of perfusion index and pleth variability index between blocking and non-blocking side (both blocks together)

	Blocked Mean±Std. deviation (*n*=40)	Unblocked Mean±Std. deviation (*n*=40)	*P*
Perfusion Index (Pİ)			
Baseline	2,54±0,666	2,44±0,939	=0,437
1th min.	5,23±2,280	2,96±1,111	<0,001
5th min.	6,44±2,032	2,93±1,037	<0,001
10th min.	7,29±1,782	3,21±1,153	=0,046
15th min.	8,19±2,615	3,05±1,140	<0,001
20th min.	8,28±2,293	2,79±0,995	=0,217
Pleth Variability Index (PVI)			
Baseline	15,35±3,585	16,23±3,765	=0,233
1th min.	16,30±4,675	16,38±6,041	=0,341
5th min.	16,30±5,805	16,82±4,787	=0,613
10th min.	15,20±4,421	17,2800±5,95863	=0,123
15th min.	15,13±5,273	18,63±4,781	=0,078
20th min.	15,23±5,091	17,55±5,491	=0,200

oxygen saturation values in the measurement time periods. Hemodynamic data of the groups are given in Table 2.

When the PI and PVI values of the patients in the blocked arm (group ISB + group ICB) were examined, the groups in the non-blocked arm were similar in terms of baseline values and 20th minute values. However, PI and PVI values were significantly lower in the arm that had block at 1st, 5th, 10th, and 15th minutes. ($p < 0.001$, p0.001, $P = 0.046$, P 0.001, respectively) [Table 3]. When the PI and PVI values in the ISB group were

Table 4: Comparison of perfusion index and plet variability index by blocks

	Interscalene (*n*=20)			Infraclavicular (*n*=20)		
	Blocked Mean±SD. Deviation	Unblocked Mean±SD. Deviation	*P*	Blocked Mean±SD. Deviation (*n*=20)	Unblocked Mean±SD. Deviation (*n*=20)	*P*
Perfusion Index						
Baseline	2,23±0,391	2,07±0,571	=0,218	2,85±0,746	2,82±1,088	=0,890
1th min.	4,90±2,111	2,79±0,893	<0,001	5,56±2,445	3,14±1,294	<0,001
5th min.	6,12±1,239	2,84±0,896	=0,025	6,76±2,592	3,02±1,178	=0,048
10th min.	7,71±1,651	2,84±0,656	<0,001	6,88±1,852	3,59±1,416	=0,015
15th min.	8,62±2,278	2,93±0,741	=0,001	7,77±2,909	3,17±1,445	=0,375
20th min.	9,12±2,370	2,56±0,369	=0,629	7,44±1,924	3,02±1,336	=0,287
Pleth Variability Index						
Baseline	15,40±2,210	15,60±2,280	=0,743	15,30±4,635	16,85±4,804	=0,254
1th min.	17,80±3,365	17,80±4,299	=0,834	14,80±5,367	14,95±7,222	=0,323
5th min.	18,20±4,819	18,80±4,287	=0,449	14,40±6,193	14,85±4,522	=0,854
10th min.	16,25±3,754	18,10±5,180	=0,256	14,15±4,870	16,46±6,681	=0,284
15th min.	16,25±5,369	19,45±4,395	=0,340	14,00±5,058	17,80±5,116	=0,077
20th min.	16,20±5,512	17,15±4,955	=0,072	14,25±4,564	17,95±6,083	=0,942

Table 5: Perfusion index and pleth variability index comparison of block sides by block

	İnterskalen Mean±SD. Deviation (*n*=20)	İnfraklaviküler Mean±SD. Deviation (*n*=20)	*P*
Perfusion Index (Pİ)			
Baseline	2,2300±0,39082	2,8500 ± ,74587	=0,002
1thmin.	4,8950±2,11074	5,5600±2,44506	=0,948
5thmin.	6,115±1,2394	6,755±2,5926	=0,966
10thmin.	7,7050±1,65131	6,8750±1,85156	<0,001
15thmin.	8,6200±2,27818	7,7650±2,90866	=0,962
20thmin.	9,1150±2,36960	7,4400±1,92365	=0,080
Pleth Variability Index (PVI)			
Baseline	15,40±2,210	15,30±4,635	0,253
1thmin.	17,80±3,365	14,80±5,367	0,084
5thmin.	18,20±4,819	14,40±6,193	0,562
10thmin.	16,25±3,754	14,15±4,870	0,210
15thmin.	16,25±5,369	14,00±5,058	0,897
20thmin.	16,20±5,512	14,25±4,564	0,695

examined; Baseline and 20th min values were similar in the arm with block and the group without block. However, the 1st, 5th, 10th and 15th minutes were statistically higher. ($p < 0.001$, $P = 0.025$, $P = 0.001$, p0.001, respectively). PI and PVI values measured at baseline, 15th and 20th minutes were similar in the ICB group. However, the 1st, 5th, and 10th minute PI and PVI values were significantly higher in the block arm. ($p < 0.001$, $P = 0.048$, $P = 0.015$, respectively). The PI and PVI values in the blocked and non-blocked arms of the patients who underwent ICB and ISB are given in Table 4. Groups; The PI and PVI values of the blocks were similar. [Table 5]

Discussion

In regional anesthesia applications, the development of motor and sensory blockade is evaluated while the patient is being operated on. However, subjective reasons such as education, stress, ambient temperature, cognitive disorders, etc., make it difficult to evaluate the success of the blockade.[6] As it is known, a successful nerve block includes a sympathetic block as well as a motor and sensory block. Vasodilatation due to sympathetic blockade causes an increase in regional blood flow and thus an increase in the PI index. PI is not affected by physiological factors such as HR, ambient temperature, and blood oxygen saturation; It allows it to be used as an objective method in the evaluation of block success.[7,8] In our study, we observed that PI increased significantly in the 1st minute in the extremity that underwent brachial plexus block. This result showed that PI can be used as a fast and effective method in the evaluation of block success.

Factors such as pain, low pain threshold, stress, and temperature affect the sympathetic system. Therefore, individual differences of 0.6-4.7% can be seen in the basal values of the PI index.[9] Another factor that can affect the PI index is the compression by the volume of the local anesthetic. With the widespread use of USG, the volume of local anesthetic used decreased. For this reason, it has partially reduced the falls that may occur due to compression in the PI.

It was shown in the study conducted by Kuş *et al*.[9]on 46 patients in 2013 that there was a 120% increase in the PI index at the 10th minute in patients who had successfully performed the brachial plexus. Abdelnasser *et al*.[7] stated in their published research that it is

healthier to use the variability rate in PI instead of the absolute PI value due to the high individual variability rate in PI, and that a 1.4 PI ratio is an indicator of successful block. Bereket *et al*.,[10] in their study on 40 patients who underwent 40 brachial plexuses, recorded an increase of approximately 200% in the 10th minute of PI. However, in the 20th and 30th minutes, they showed that this upward momentum tended to decrease. In our study, PI values started to increase from the 1st minute when compared to the non-blocked arm. This result showed that PI is an early indicator of block success. In addition, we found that both groups were similar in the analysis of changes in PI in patients who underwent infraclavicular block and interscalene block. In the changes within the groups, PI indexes in both groups increased from the 1st minute compared to the non-blocked arm. However, it was similar to the arm without PI block at the 15th and 20th minutes in patients with infraclavicular block. This result showed that PI is an early indicator of block success.

Kim *et al*.[11] added ephedrine as an adjuvant to local anesthetics in their research. They found that PI was similar in the group that received ephedrine and the group that did not. As it is known, ephedrine may cause a decrease in regional blood flow, since it is a vasoconstrictive agent. Kim *et al*. attributed this result to slow absorption of perineural ephedrine.

In our study, the interscalen group and the infraclavicular block group had similar PI indices. Eskin and Ceylan reported that in their study on 60 patients in 2020, interscalen block increased the PI index more than the infraclavicular and subraclavicular groups, and therefore it could be used as a more suitable option for microsurgery.[12] The reason for this increase in intercalen block seems to be that the stellate ganglion is close to the area where the intercalen block was performed. Yamazaki *et al*.[13] showed an increase in PI in patients who underwent stellate ganglion block. There was no supraclavicular group in our study. Therefore, data belonging to the supraclavicular group were not recorded. Çelik and Olmez Kavak,[8] on the other hand, reported that the PI index was similar in patients who underwent infraclavicular, subraclavicular, and axillary procedures.

The PVI index is a non-invasive method used in the estimation of fluid needs in recent years. It shows the PI changes in the respiratory period. $((PI_{max} - PI_{min})/PI_{max} \times 100)$. Studies have shown that PVI decreases despite the increase in PI.[8,14] There are studies in the literature reporting that PVI can be used as an alternative to SVP.[15,16] In our study, the values of the PVI index were similar, although the PI increased when the arm with the block was compared with the arm without. Again, there was no difference between the interscalen group and the infraclavicular block. However, there are very few studies in the literature in patients with brachial plexus and more research is needed.

The number of cases is limited, as our study was single-centered. Therefore, it limited the efficiency of the results obtained.

Conclusion

In our study, we observed an increase in PI from the 1st minute compared to the non-blocked arm in successful block applications. We consider the early indicator of PI in the evaluation of block success. In our study, we did not observe a significant change in the arm that was blocked and the arm that was not treated with PVI. There are few studies between brachial plexus block and PVI index. Further study is needed in this regard.

Ethics committee approval

For our study, approval of Malatya Turgut Özal University Clinical Research Ethics Committee dated 08.03.2021 (August 3, 2021) and numbered 2021/43 as obtained.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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