ORIGINAL ARTICLE

Comparison of the efficacy of five different objective methods to evaluate the success of infraclavicular block; which one of them is a reliable and early indicator?

Abdulhakim Şengel, M.D.,[1] Mahmut Alp Karahan, M.D.,[2] Nuray Altay, M.D.,[2] Orhan Binici, M.D.,[2] Veli Fahri Pehlivan, M.D.,[2] Ahmet Atlas, M.D.[2]

[1]Department of Anhestesiology and Reanimation, Siverek State Hospital, Şanlıurfa-*Türkiye*

[2]Department of Anhestesiology and Reanimation, Harran University Faculty of Medicine, Şanlıurfa-*Türkiye*

ABSTRACT

BACKGROUND: Traditional methods that evaluate the success of peripheral nerve block have been replaced by methods that allow objective evaluations over time. Multiple objective techniques for peripheral nerve block have been discussed in the literature. This study aims to investigate whether perfusion index (PI), non-invasive tissue hemoglobin monitoring (SpHb), tissue oxygen saturation (StO_2), tissue hemoglobin index (THI), and body temperature are reliable and objective methods to evaluate the adequacy of infraclavicular blockage.

METHODS: Ultrasound-guided infraclavicular block in 100 patients undergoing forearm surgery. PI, SpHb, StO_2, THI, and body temperature measurements was recorded 5 min before the block procedure, right after the procedure, and until the 25th min after the procedure at 5-min intervals. These values were compared between the blocked limbs and non-blocked limbs while being statistically compared between the successful and failed block groups.

RESULTS: Although there were significant differences between the groups of blocked extremity and non-blocked extremity in terms of StO_2, THI, PI, and body temperature, there was no significant difference between these groups in terms of SpHb. Moreover, a significant difference was detected between the groups of successful block and failed block in terms of StO_2, PI and body temperature, while there was no significant difference between these groups in terms of THI and SpHb.

CONCLUSION: StO_2, PI, and body temperature measurements are the simple, objective, and non-invasive techniques to be used to evaluate success of block procedures. According to the receiver operating characteristic analysis, StO_2 is the specific parameter with the highest sensitivity among these parameters.

Keywords: Body temperature; infraclavicular block; near infrared spectroscopy; non-invasive total hemoglobin monitoring; perfusion index; tissue oxygen saturation.

INTRODUCTION

At present, peripheral nerve blocks are increasingly used for both anesthesia and postoperative analgesia, particularly in extremity surgeries.[1] These blocks are the most common regional anesthesia method after spinal anesthesia. Brachial plexus block, which is one of the most used peripheral nerve blocks, allows regional block of the shoulder, arm, wrist, and forearm.[2] Infraclavicular block is a brachial plexus block technique that is easy to apply under ultrasonography (USG) guidance in the upper extremity surgeries and can be used in outpatient surgeries.[3] Whether the peripheral nerve block for anesthesia has been successful, it is determined by evaluating the levels of sympathetic, sensory, and motor blocks.[4]

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Address for correspondence: Abdulhakim Şengel, M.D.
Siverek Devlet Hastanesi, Anesteziyoloji ve Reanimasyon Kliniği, 63600 Şanlıurfa, Türkiye
Tel: +90 414 - 552 12 46 E-mail: ahsengel121@gmail.com

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Many different techniques have been employed throughout the development process of peripheral nerve blocking depending on whether a block procedure was concluded to be successful or not. The comments on this subject were based on mostly traditional methods and caused certain difficulties on a subjective basis, as well as different interpretations of assessment varying on a personal basis. However, the necessity of quality communication with the patient[5] led researchers to look for new ways and required non-invasive methods that do not require patient cooperation and provide faster evaluation. Therefore, traditional methods have been replaced by the methods that allow objective evaluations over time.

These objective methods were introduced based on the evaluation of the local vasodilation, increased blood flow, and increased skin temperature resulting from the sympathetic blockage in the blocked area after the block procedure.[5]

Multiple objective techniques for peripheral nerve block have been discussed in the literature. These techniques include methods such as perfusion index (PI), plethysmographic variability index, non-invasive tissue hemoglobin monitoring (SpHb), tissue oxygen saturation (StO_2), tissue hemoglobin index (THI), and body temperature.[6–13]

This study is intended to compare the superiority of near infrared spectroscopy (NIRS), StO_2, THI, PI, SpHb, and body temperature methods along with the routine vital signs and traditional methods in assessing the block success and adequacy of the infraclavicular brachial plexus block procedures that we applied under USG guidance in cases undergoing forearm surgery.

We think that our study will contribute to the literature, considering that unlike the existing literature studies, it is more comprehensive (due to the wide variety of parameters examined) and that it will obtain more objective data from patients who are not awake or unconscious or who cannot express themselves fully, such as young pediatric patients.

MATERIALS AND METHODS

Ethics

Ethical approval for this study was provided by Harran University Medical Faculty's Ethics Committee, Şanlıurfa, Turkey (Chairperson Prof Dr. Fuat Dilmeç) on February 14, 2019. It was registered with the number ACTRN12621000588897 at the clinical research center of Australian New Zealand Clinical Trials Registry. Our study was performed between February 2019 and December 2019.

Patient Selection

We calculated the sample size according to the results of with previous similar studies and the first 15 patients in the study. From these differences and assuming a two-tailed α value of 0.05 (sensitivity 95%) and a β value of 0.20 (study power: 80%, effect size: 0.80), we determined that at least 38 patients were required for our study by statistical software Package G Power (version 3.1.9.2; Franz Faul and Edgar Erdfelder, Trier, Germany). While calculating the sample size, an evaluation was made between the extremity with the block and the extremity without the block, as well as between the groups with successful and unsuccessful block. We decided to enroll 100 American society of anesthesiology (ASA) I-II patients aged 18–65 who will undergo forearm surgery. The patients who were accepted to the study were informed about the study both verbally and in writing. Moreover, informed consent was issued for patients who accepted to participate in the study.

Exclusion criteria included patients who did not want to participate in the study; patients who were not included in ASA-I and ASA-II; patients who were not in the age range of 18–65; presence of a previous neurological sequel in the limb to be blocked; patients with a history of chronic vasoactive drug usage; patients with a history of diabetes mellitus; patients contraindicated for infraclavicular block because of the presence of open wound and infection in the area to be blocked; patients with a history of coagulopathy disorder; patients with a history of allergy to amide group Local anesthetics (LA); patients who could not cooperate; and patients with kidney and liver failure, pregnant, and breastfeeding patients.

Procedures Infraclavicular Brachial Plexus

Block patients undergoing forearm surgery were taken to the pre-operative preparation unit at 23–24°C before surgery. Then, block processing was performed under constant room temperature. In addition, the patients were followed up in the same room after the block. Standard monitoring, including non-invasive arterial blood pressure, electrocardiography, and peripheral oxygen saturation (SpO_2), was performed in the patients who were taken to the operating table. In the upper extremity where no operation was scheduled, after the peripheral vascular access was established with an 18-or 20-gauge cannula, an infusion of 10 mL/kg of 0.9% NaCl liquid (with a temperature of 36°C) was started for maintenance purposes. Midazolam (Zolamid 5 mg/mL) of 0.02–0.03 mg/kg was administered i.v. to the patients for sedative purposes. By communicating with the patients, 2 L/min of oxygen was given to the patients through the nasal route during the block procedure and during the follow-up. For recording StO_2 and THI measurements, NIRS probe (Inspectra™ StO_2 Spot Check-Model 300 (Hutchinson Technology Inc., Hutchinson, MN, USA) device probe) was placed on the palm of the hand to cover the thenar ridge of the hand to be blocked as well as on the palm of the other hand. A special pulse oximetry sensor (R1 25 SpHb SpO_2 SpMet Adult Pulse CO-Oximeter Adhesive Sensor) was placed on the middle fingers of both hands.

This sensor (Masimo IC model: the RDS7A device (USA)) was used to obtain the data to be recorded. Moreover, 5 min before and during the procedure, systolic blood pressure and diastolic blood pressure, heart rate, and SpO_2, as well as the StO_2 and THI data obtained from the NIRS device, and the PI and SpHb data from in the Pulse CO-Oximeter device were all recorded. After these basal values were recorded, the procedure stage was started.

To perform the block, it was planned to move toward the axillary artery with USG guidance using a 22 gauge, 50 mm, insulated facet tip needle (B. Braun Stimuplex, Melsungen AG, Germany). Before the intervention with the block needle, 2 mL lidocaine was administered for skin-subcutaneous infiltration to the area planned to be injected. After the skin infiltration, the long axis method was employed and the lateral, medial and posterior cords around the axillary artery were accessed with simultaneous USG-imaging, and the block needle was directed to the nearest of each cord with local anesthetic. After reaching the desired area, after negative aspiration test (by repeating this test after every 5 mL LA injection), the prepared local anesthetic solution was injected into the described areas. To avoid an unwanted situation, when the distribution of LA could not be completely confirmed on the US screen, when any resistance was encountered at the time of injection, or when the patient described pain during the injection, the needle was redirected with fine maneuvers. Local anesthetic solution of 15 mL of 2% lidocaine (Lidon 100 mg/5 mL On Farma), and 15 mL of 0.5% bupivacaine (Buvasin 5 mg/mL, 20 mL, Vem Ilaç, Turkey) were prepared. Lidocaine was used for its fast-acting and bupivacaine was preferred for its long-acting. These two different LAs were administered together in the same syringe. Therefore, the concentration of lidocaine in the prepared mixture was 1% and the concentration of bupivacaine was 0.25%. After the entire solution was administered into the desired areas, the U-shaped distribution of the solution around the axillary artery was observed using USG.

Clinical Evaluation Block Assessment

The anesthetist performing the block operation and the anesthetist performing the post-procedure follow-up consisted of different people. For follow-up, the minute 0 was accepted as the moment when the procedure was terminated and the needle was removed from the skin. After the block procedure (the moment of removal of the needle from the skin was accepted as the minute 0), the StO_2, THI, PI, SpHb, and body temperature (the temperature of the extremities was measured with an infrared thermometer (Mesilife DT-8806) from the intermediate region of the two arteries, not corresponding to the radial and ulnar artery traces on the inner side of both wrists) data, was recorded from both the blocked extremity and the other extremity one by one at the minutes 0, 5, 10, 15, 20, and 25.

Furthermore, 30 min after the block procedure, it was recorded whether the block was holding or not after the evaluation with Bromage scale, the sensory test for loss of cold sensation and Pin-prick test in the extremity where the block was performed. It was accepted as complete sensory block when there was no movement in the arm or hand according to the Bromage Scale, when the patient did not feel the cold sensation in all the dermatomes of interest according to the Cold Sense Loss Test, and pain sensation did not occur in all of the relevant dermatomes according to the Pin-prick Test. Then, the compatibility of objective tests and subjective tests with each other was checked.

Statistical Analysis

Compliance of numerical data to normal distribution was tested with Shapiro–Wilk test. Mann–Whitney U test was used to compare non-normally distributed variables between the groups of successful and failed block. Furthermore, the Wilcoxon test was used to compare the non-normally distributed variables between the block group and the control group, while the Freidman test was used to compare the measurements obtained at seven different times (intragroup comparison), and Dunn's multiple comparison test was used to determine the times reported to be significant. Inter-method consistency was tested with Kappa statistics. Mean ± standard deviation values were given for summarizing numerical variables, and numbers and % values were given for categorical variables. SPSS windows 24 version was used for statistical

Table 1. Demographic data of the cases

Variables	Descriptive statistics (n=100) Mean±SD	
Age	37.37±13.54 (min=18-max=64)	
Height	168.74±7.04	
Weight	74.92±12.94	
Body mass index	26.39±4.78	
	n	**%**
Gender		
Male	54	54.0
Female	46	46.0
ASA		
1.00	45	45.0
2.00	55	55.0
Additional disease		
No	74	74.0
Yes	26	26.0
Smoking		
No	66	66.0
Yes	34	34.0

ASA: American society of anesthesiology risk classification; SD: Standard deviation.

analysis and analysis results were evaluated at 95% confidence interval (CI) with $p<0.05$ considered to be statistically significant. Receiver operating characteristic (ROC) analysis was used between the block and control groups to determine the sensitivity and specificity of the parameters found to be significant in the evaluation of the block procedure, and the areas under the curve of each predictor were calculated and compared with each other.

RESULTS

A total of 100 patients aged 18–65 years who underwent forearm surgery under infraclavicular plexus block were included in the study. The mean age was 37.37±13.54 years. Table 1 shows the demographic data of the patients. Block failure occurred in five patients (5%) who were then switched to general anesthesia. The five parameters (Temperature, StO_2, THI, PI, and SpHb) discussed in the study were compared between the limb with block and limb without block, as well as between the successful and unsuccessful block groups. There were no complications related to the technique or local anesthetic injection.

When we look at the comparison of the parameters between the blocky limb and the non-blocked limb, significant differences were detected in temperature (p=0.001), StO_2 (p=0.001), THI (p=0.001), and PI (p=0.001) in all time intervals, starting from the 0th min after the block was applied, until the 25th min after the block. No significant difference was detected in SpHb at any of these time intervals (Fig. 1).

When the groups of successful block and failed block were compared, StO_2 was reported to be significantly higher in all measurements starting from the 5th min after the block (p=0.002–0.011). The temperature was reported to be highly significant in other measurements starting from the 15th min (p=0.044–0.012). PI was reported to be significant in other measurements starting from the 5th min but not at the 15th

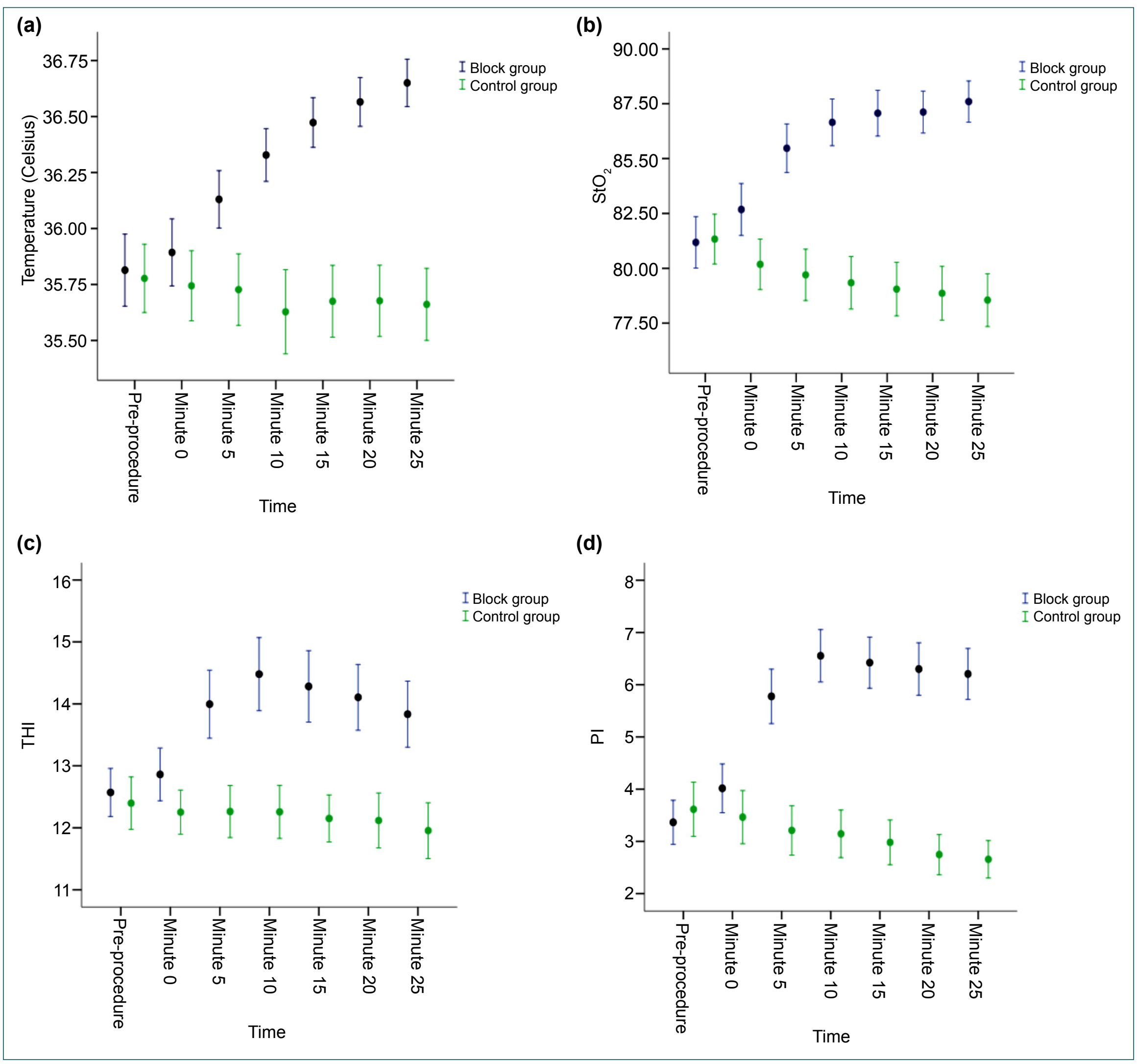

Figure 1. Variation of graphs between block group and control group. StO_2: Tissue oxygen saturation; THI: Tissue hemoglobin index; PI: Perfusion index.

min (p=0.044–0.002). There was no significant difference between the groups in terms of SpHb value (Fig. 2).

In the ROC analysis of the variables, the most significant result in terms of the values of StO_2 was found to be at the 5th min, the cutoff value to be 78.5, the area under the curve to be 0.806, the sensitivity to be 93% and specificity to be 58% (Fig. 3). The most significant result of PI is at the 25th min with the cutoff value being 2.45, the area under the curve to be 0.791, the sensitivity to be 89% and the specificity to be 51% (Fig. 4). The ROC analysis result where temperature was the most significant was at the 15th min with the area under the curve being 0.833, the cutoff value being 36.45, sensitivity being 63%, and specificity being 60% (Fig. 5).

Compared to the pre-procedure time, the mean percentage change of PI increased by 29% at min 0.110% at the 5th min, 150% at the 10th min, 146% at the 15th min, 144% at the 20th min, and 138% at the 25th min. Compared to the pre-procedure time, the mean percentage change of StO_2 increased by 2% at min 0.5% at the 5th min, 7% at the 10th and 15th min, and 7% at the 20th and 25th min. Compared to the pre-procedure time, the mean percentage change of THI variable increased by 3% at the min 0.12% at the 5th min, 16% at the 10th min, 14% at the 15th min, 13% at the 20th min, and 11% at the 25th min. Compared to pre-procedure time, the mean percentage change of the temperature variable presented no change at minute 0 and increased by 1% at the 5th and 10th min and by 2% at the 15th, 20th, and 25th min. Compared to pre-procedure time, the mean percentage change of the SpHb variable presented no change at the minutes 0, 15, 20, and 25 but increased by 1% at the 5th and 10th min (Fig. 6).

When we evaluated the success of the block with traditional methods before sending the 100 patients undergoing the block procedure to the operating room, no sensory loss was observed in 5 patients in the Pinprick test and the sensory test for loss of cold sensation. In 77 patients, it was observed

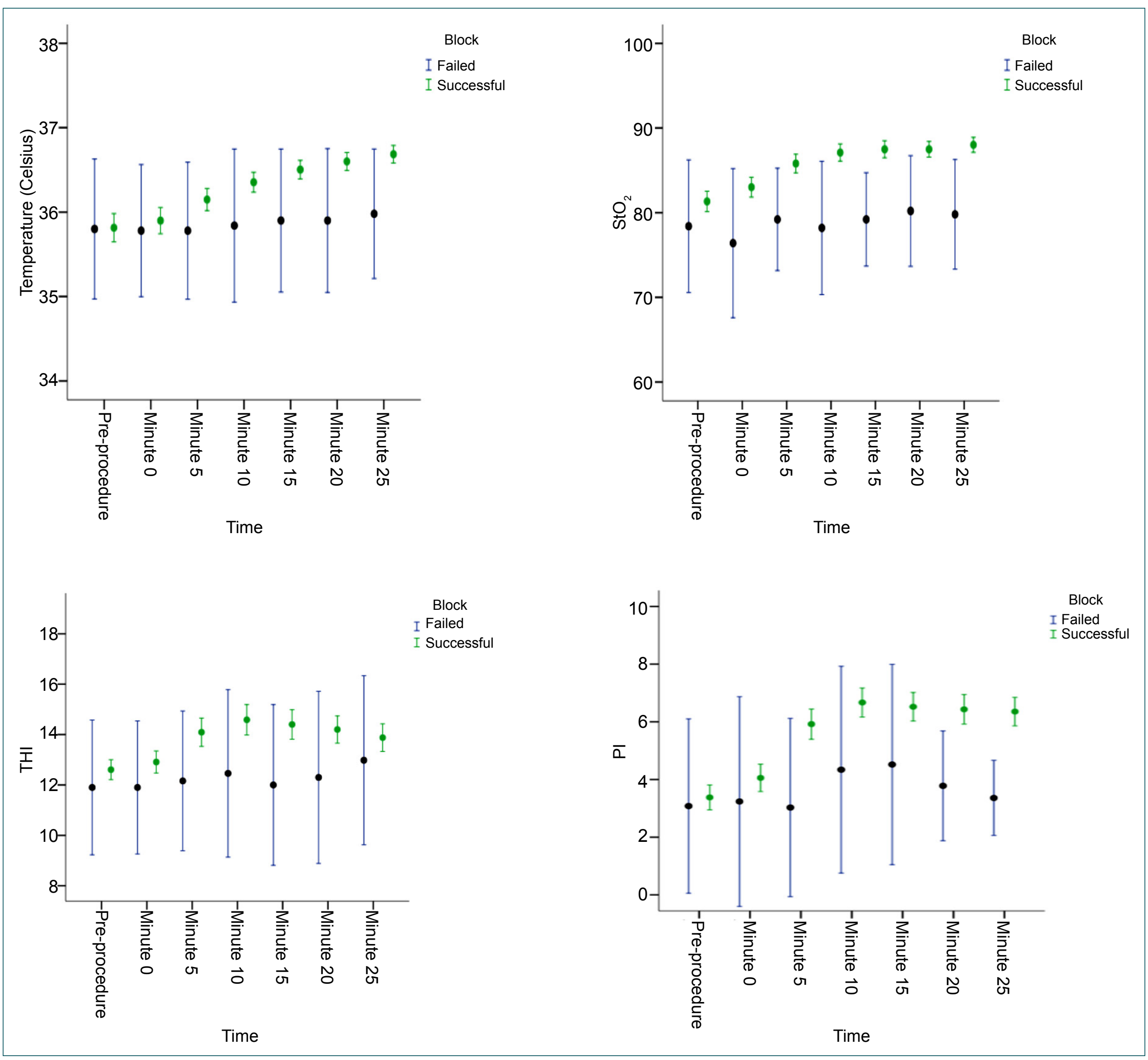

Figure 2. Variation of graphs between the groups of successful block and failed block. StO_2: Tissue oxygen saturation; THI: Tissue hemoglobin index; PI: Perfusion index.

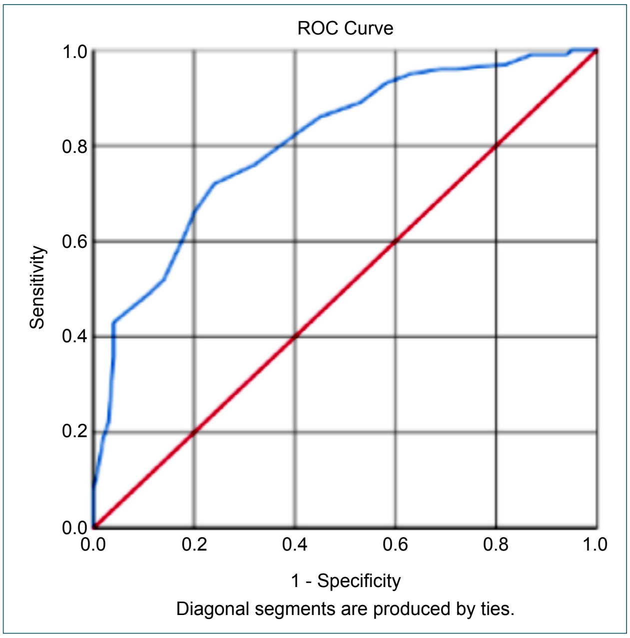

Figure 3. The ROC analysis StO_2 between the block group and the control group. The ROC analysis of StO_2 between the block group and the control group ROC curve of StO_2 for the STO value. Cutoff value: 78.5, Sensitivity: 93%, and Specificity: 58% (Fig. 3).

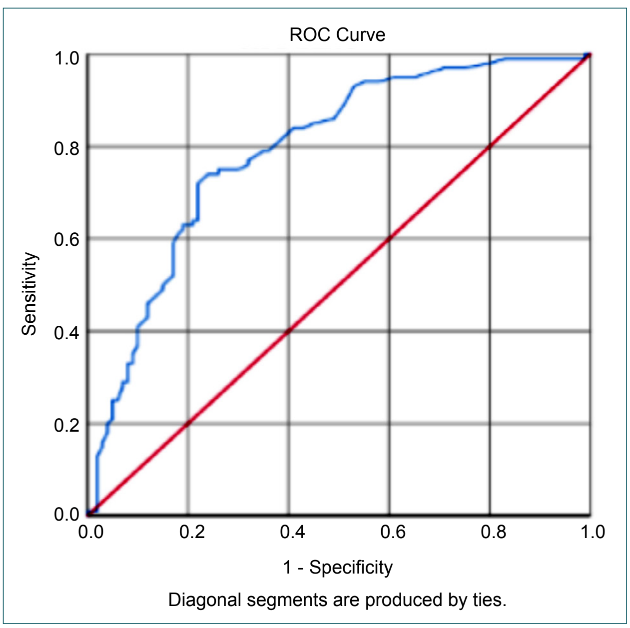

Figure 4. The ROC analysis of PI between the block group and the control group. The ROC analysis of PI between the block group and the control group ROC curve for PI value. Cutoff value: 3.15, Sensitivity: 82%, and Specificity: 39% (Fig. 4).

that there was no feeling of tactile sensation and pain. A complete consistency was observed between the Pinprick test and the sensory test for loss of cold sensation (Kappa=1.000, p=0.001) (Table 2).

DISCUSSION

The present study is intended to investigate whether non-in-

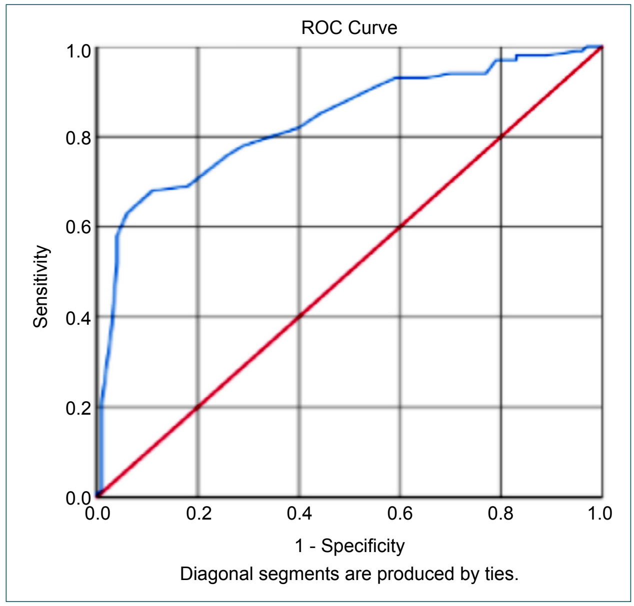

Figure 5. The ROC analysis of temperature between the block group and the control group. The ROC analysis of temperature between the block group and the control group is the ROC curve for the temperature n value. Cutoff value: 36.45, Sensitivity: 63%, and Specificity: 60% (Fig. 5).

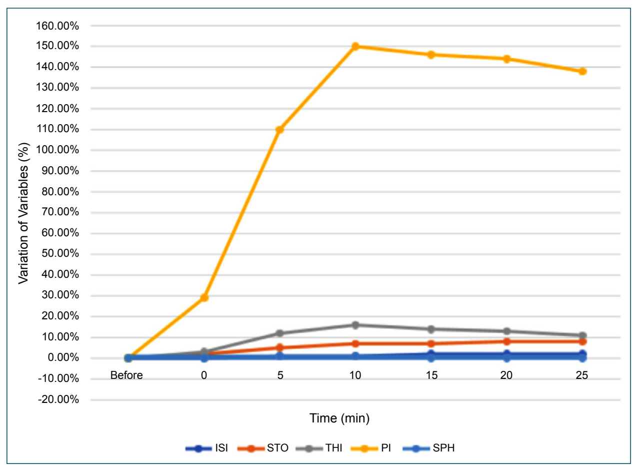

Figure 6. The percentage changes in mean values of the variables of temperature, StO_2, THI, PI, SpHb.

vasive, objective, and observer-independent methods of PI, SpHb, StO_2, THI, and body temperature are an early and reliable predictor of block success or failure in patients undergoing forearm surgery. Our study is the study with the biggest sample size and the first study in which objective methods that are normally used separately to measure block success are evaluated all together. Temperature, StO_2, THI, and PI values were significantly different in all these parameters – except for SpHb-between the block group and the control group after minute 0. We determined PI and StO_2 as objective methods since they started at the earliest from the 5th min and continued in the late period.

NIRS is a non-invasive method used to detect StO_2 based on

Table 2. Confirmation of block success and block failure with traditional diagnostic methods

	n	%
Bromage scale		
Motor strength is reduced but arm is moving	13	13.0
Arm is immobile but fingers are moving	41	41.0
Full block no movement in hand and arm	46	46.0
Pin-prick test		
No sensory block	5	5.0
There is tactile sensation and no pain	18	18.0
There is no tactile sensation and pain	77	77.0
Sensory test for loss of cold sensation		
No sensory block	5	5.0
Analgesia (the patient feels the touch but does not have the cold sensation)	18	18.0
Anesthesia (patient does not feel the touch)	77	77.0

the microcirculation perfusion in the area of measurement where near infrared light of different wavelengths (680–800 nm) is used for measurement. NIRS detects differences in oxygen saturation caused by changes in tissue oxygen consumption or oxygen delivery. It is mostly used as a cerebral oximeter monitor in critically severe cases.[14] Although there have been publications about the use of StO_2 in evaluating peripheral nerve block success, there are few studies in the literature regarding its use to measure the success of peripheral block.[8,9,15–17]

In the first study, which showed that NIRS can capture the increase in local tissue perfusion occurring after the block, a 15% increase in oxygen saturation was detected in the limb that was performed block procedure after the brachial plexus blockage (interscalene, supraclavicular, infraclavicular, or axillary). Significant increases in StO_2 values were observed within 5 min after the completion of the block, which occurred before the patients perceived sensory and motor loss.[8] Various other subsequent studies in which peripheral nerve blocks were performed in the lower and upper extremities reported that there were statistically significant differences in StO_2 values in the blocked limbs and the control limbs.[15] In these studies, the increases were significant after the 5th min, and there was a significant difference between the blocked limb and the non-blocked limb and that StO_2 could successfully demonstrate peripheral nerve block as a non-invasive parameter. Our study has a greater sample size compared to other studies and was conducted on 100 cases. Our results are similar to the previous results; in the comparison between the groups of successful and failed block, there is a significant increase starting from the 5th min and including the 25th min.

Another parameter other than StO_2, which we could measure with the NIRS method, was THI. THI is the tissue hemoglobin concentration used for StO_2 measurement and measured quantitatively from the thenar ridge using a probe. It is also accepted as a measurement of hemoglobin signal strength, which is useful for determining whether the StO_2 sensor is best positioned on the muscle.[10] In a single study related to its use in peripheral block, Karahan et al.[9] investigated the change in StO_2 in patients who underwent infraclavicular block and studied THI values along with StO_2 and reported that THI was a sign of vasodilation and showed a significant difference over time in the blocked limb. In our study, although we reported a significant difference in THI values between the blocked extremity and control extremity groups, no significant difference was reported between the groups of successful and failed block.

Another objective value by which the brachial plexus block success is followed in the literature is PI. The PI is a numerical value that reflects the relative strengths of the different components of the infrared signal returning from the monitoring area, showing the ratio of pulsatile blood flow to non-pulsatile or static blood in the peripheral tissue. It has been shown to reflect real-time changes in peripheral blood flow based on pulse oximetry continuously and noninvasively. Since PI is an indicator of peripheral blood flow and peripheral blood flow in the upper extremities is a clinical sign of an effective block, increased PI on the side of the block can be a reliable approach to determine the effectiveness of infraclavicular block.[5]

It has been shown that sympathetic blockage is correctly detected by evaluating the increase in PI shortly after epidural block, pediatric caudal block, stellate ganglion block, and interscalene nerve block.[11,12,18,19] The study by Abdelnasser et al.[20] on the use of PI measured by the pulse oximetry method in predicting the success of supraclavicular brachial plexus block concluded that high PI values had 100% sensitivity and specificity for successful block. Separate studies by Kus et al.[5] and Nieuwveld et al.[21] concluded that PI is a successful infraclavicular indicator in patients in whom infraclavicular block was applied. Similar to the studies published in the literature, based on the comparison of the PI value between the groups, our study reported a significant difference between the blocked and non-blocked groups starting from the minute 0. The data that we obtained in our study were similar to the data obtained from the previous studies. When we examine the significant difference between the groups of successful block and failed block, a significant difference emerged at the 5th min and afterward in terms of PI.

Another popular objective parameter investigated is skin temperature. It is claimed that tissue blood flow increases because of the vasodilation resulting from the sympathetic block in such blocks and increase in the skin temperature, and this increase in skin temperature shows block success with higher specificity and sensitivity compared to the pin-prick and cold sensation tests.[22] With this theory, studies investigated whether a simple infrared thermometer could reliably predict block efficacy after infraclavicular brachial plexus block and reported that the measurement of skin temperature with infrared thermometry would be an inexpensive and easy-to-use predictor of the early stage of block success or failure in a particular nerve distribution.[7]

In a study evaluating distal skin temperature to predict the success of lateral infraclavicular block, the authors concluded that the temperature difference predicts a successful block with 92% sensitivity (95% CI, 83–97%). They determined the positive predictive value of the test as 95% (CI, 86–98%). Consequently, they reported that the difference in skin temperature measured between the blocked and non-blocked hands is a valid and reliable diagnostic test to predict successful lateral infraclavicular block.[23] In the study where thermochromic nail polish was used to predict the success of infraclavicular brachial plexus block, they reported a positive predictive value of 96% and a sensitivity of 94% for thermochromic nail color change. Consequently, this study reported that thermochromic nail polish color change is a valid and reliable indicator for predicting block success.[24]

In our study, when we measured the temperature change between the blocked limb and the non-blocked limb with an easy-to-use infrared thermometer device, a significant difference was observed between the blocked and non-blocked groups starting from the minute 0. However, when we examine the difference between the groups of successful block and failed block, no significant difference was observed in the 1st 10 min while a significant increase was found in the group of successful block after the 15th min. It was also observed that this increase continued at the 20th and 25th min as well.

Developing technology leads scientists to look for alternatives. Considering that the technology is non-invasive for these reasons and its ability to provide continuous, real-time data can be associated with events occurring at the bedside, SpHb monitoring offers us a new paradigm, new possibilities for better, and healthier follow-up.[25]

The study where Bergek et al.,[6] measured noninvasive hemoglobin and Pleth Variability Index after brachial plexus block, it was evaluated that SpHb values increased compared to basal value and this was a significant difference. It was stated that there was no significant difference in this parameter in the control arm. In the same study, it was stated that SpHb was a measure of intravascular Hb concentration and it was stated that vascular structures were affected depending on the anesthesia technique applied, and these values may change accordingly.

When we did intragroup comparisons of SpHb values in our study, no significant difference was observed between the blocked and non-blocked groups. Moreover, when we look at the comparison between the group of successful block and the group of failed block, no significant difference was reported.

Our study has some limitations. First, in our study, we could not achieve a successful block in five patients, and our objective parameter in these patients did not change significantly compared to baseline. Thus, the inability to produce significant increases in our objective parameter may be a reliable sign of block failure, but this should be confirmed in a larger-scale study with more cases of block patients. Second, we targeted patients scheduled to undergo any type of forearm surgery. The results of the study, which we have limited to one type of specific surgery, may not give an idea about how it will end in other specific surgeries. Third, it is a common practice to sedate patients in peripheral nerve blocks. In our study, midazolam was given to the patients for sedation. Benzodiazepines can cause not only sedation but also amnesia and may impair the perception and identification of the senses, and mild sedation probably does not greatly impair the perception of the appearance of periarterial swelling caused by local anesthesia. Therefore, the applicability of our findings in sedation patients remains unclear.

When we compared the parameters among themselves, we found that, out of all the parameters, including StO_2, THI, PI, SpHb, and skin temperature, THI showed a significant difference between the blocked group and the control group, but there was no significant difference in terms of THI between the groups of successful block and failed block. In SpHb, no significant difference was neither reported between the block group and the control group nor between the groups of successful block and failed block. When we evaluated StO_2, PI and body temperature parameters, we found that StO_2 and PI presented with a significant difference between the groups of successful block and failed block at an earlier stage, compared to body temperature.

The parameters that we discussed in our study (Temperature, StO_2, THI, PI, and SpHb) are the parameters that change after the sympathetic block, which may result from the more performed block. Whether these parameters can be used instead of sensory block or surgical anesthesia poses a question mark by some authorities. Because a small amount of local anesthetic reaching the nerves can cause sympathetic blockade even in unsuccessful blocks, so the significant difference that may occur in these parameters may disappear (as in THI in our study). In our study, we compared the limb with block with the limb without block, and also compared the successful block group with the unsuccessful group. In these two different comparisons, we found significant differences in temperature, StO_2, and PI. Hence, we actually showed that these parameters can detect this even if the block fails. However, more work is needed on this subject.

When we looked at the ROC curve for StO_2, PI and body temperature parameters between the block and control groups, we found that StO_2 was a more sensitive parameter than PI and body temperature. However, when compared with the literature, the sensitivity-specificity values obtained as a result of our study seem to be lower. In this sense, it raises doubts whether the parameters examined can reliably evaluate the success of the block. Therefore, there is a need for more studies in which objective studies that will evaluate the success of the block will be discussed.

Conclusion

Of all the StO_2, THI, PI, SpHb, and skin temperature measurement parameters in infraclavicular plexus blocks, StO_2, PI, and skin temperature measurements are simple, objective, and non-invasive techniques to evaluate the success or failure of the blocks. StO_2 is the parameter with the highest specificity and sensitivity rate among these parameters, which start early and continue in the late period.

Ethics Committee Approval: This study was approved by the Harran University Faculty of Medicine Clinical Research Ethics Committee (Date: 14.02.2019, Decision No: 01/07).

Peer-review: Externally peer-reviewed.

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ORİJİNAL ÇALIŞMA - *ÖZ*

İnfraklaviküler blok başarısını değerlendirmek için beş farklı objektif yöntemin etkinliğinin karşılaştırılması: Hangisi daha güvenilir ve erken bir göstergedir?

Dr. Abdulhakim Şengel,[1] Dr. Mahmut Alp Karahan,[2] Dr. Nuray Altay,[2] Dr. Orhan Binici,[2] Veli Fahri Pehlivan,[2] Dr. Ahmet Atlas2

[1]Siverek Devlet Hastanesi, Anesteziyoloji ve Reanimasyon Kliniği, Şanlıurfa
[2]Harran Üniversitesi Tıp Fakültesi, Anesteziyoloji ve Reanimasyon Anabilim Dalı, Şanlıurfa

AMAÇ: Periferik sinir bloğunun başarısını değerlendiren geleneksel yöntemlerin yerini zamanla objektif değerlendirmelere izin veren yöntemler almıştır. Literatürde periferik sinir bloğu için çoklu objektif teknikler tartışılmıştır. Bu çalışma, infraklaviküler blokajın yeterliliğini değerlendirmek için perfüzyon indeksi (PI), non-invaziv doku hemoglobin monitörizasyonu (SpHb), doku oksijen satürasyonu (StO_2), doku hemoglobin indeksi (THI) ve vücut sıcaklığının güvenilir ve objektif yöntemler olup olmadığını araştırmayı amaçlamaktadır.

GEREÇ VE YÖNTEM: Önkol cerrahisi geçiren 100 hastada ultrason eşliğinde infraklaviküler blok, PI, SpHb, StO_2, THI ve Vücut Sıcaklığı ölçümleri blok prosedüründen 5 dakika önce, işlemden hemen sonra ve işlem sonrası 25. dakikaya kadar 5'er dakikalık aralıklarla kaydedildi. Bu değerler, başarılı ve başarısız blok grupları arasında istatistiksel olarak karşılaştırılırken, bloke olan ve bloke olmayan uzuvlar arasında karşılaştırıldı.

BULGULAR: Bloke ve bloke olmayan ekstremite grupları arasında StO_2, THI, PI ve vücut ısısı açısından anlamlı fark olmasına rağmen, SpHb açısından bu gruplar arasında anlamlı fark yoktu. Ayrıca başarılı blok ve başarısız blok grupları arasında StO_2, PI ve vücut ısısı açısından anlamlı fark saptanırken, bu gruplar arasında THI ve SpHb açısından anlamlı fark bulunmadı.

TARTIŞMA: StO_2, PI ve vücut ısısı ölçümleri, blok prosedürlerinin başarısını değerlendirmek için kullanılacak basit, objektif ve invaziv olmayan tekniklerdir. StO2 bu parametreler içinde erken dönem etkileri başlayıp geç dönem devam eden spesifik ve sensivite oranı en yüksek olan parametredir.

Anahtar sözcükler: Doku oksijen satürasyonu; infraklaviküler blok; noninvaziv toplam hemoglobin monitörizasyonu; perfüzyon indeksi; vücut ısısı; yakın kızılötesi spektroskopi.

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