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To evaluate the quality of successful ultrasound guided supraclavicular brachial plexus block and its correlation with perfusion index ratio

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Abstract---Background: Ultrasound-guided supraclavicular nerve block is a popular approach for anesthesia for upper limb surgeries. Perfusion index can considered as an objective measure for peripheral perfusion that can predict peripheral block success. Early and accurate detection of peripheral block success would enable rapid corrective action this would save the operating room time and improve patient satisfaction. The main objective was to evaluate the quality of supraclavicular brachial plexus block and it's correlation with Perfusion Index ratio. Method: It was a prospective observational study carried out over a period of 18 months from November 2018 to April 2020 in the department of anesthesia. Patients aged between 18 to 65 years. Written informed consent, 30 patients of either sex, belonging to ASA grade I and II, scheduled for elective upper limb, under supraclavicular brachial plexus block were selected for the study. Quality of block was made on the basis of 3 point scale. Result:

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In this study we observed that the Perfusion index was significantly higher in blocked limbed at all time points. Regarding the quality of block 90% of the patient's attained successful block in which significant increase in PI ratio was observed when compared to 10% of the patients with unsuccessful block in which no significant changes in PI ratio was observed. Conclusion: PI significantly increased in blocked limb who received an effective block but not on unblocked limb. Hence we concluded PI as a useful tool for evaluation of successful supraclavicular nerve block.

Keywords---supraclavicular brachial plexus, perfusion index ratio, upper limb.

Introduction

Ultrasound-guided supraclavicular nerve block is a popular approach for anesthesia for upper limb surgeries. The success of peripheral nerve blocks is usually evaluated by assessment of sensory and motor function; however, this method is subjective, time consuming, and depends on patient cooperation.[1] Perfusion index (PI), which is automatically calculated by pulse oximetry, provides an indication of peripheral perfusion at the sensor site.[2] The perfusion index (PI) is a numerical value for the ratio between pulsatile and non-pulsatile components of peripheral blood flow measured by a special pulse oximeter and is a measure for the level of vascular vasodilatation.[3] Perfusion Index is an indirect, non invasive and continuous measure of peripheral perfusion that provides useful information to the practicing physician in several clinical settings. Pulse oximetry provides a relatively simple means to continuously monitor PI in conjunction with other critical parameters, i.e., oxygen saturation and pulse rate. Furthermore, the PI provides a means of determining an appropriate monitoring site for pulse oximetry.The perfusion index (PI) is the ratio of the pulsatile blood flow to the nonpulsatile or static blood in peripheral tissue. Perfusion index thus represents a noninvasive measure of peripheral perfusion that can be continuously and noninvasively obtained from a pulse oximeter.[4]

The brachial plexus is a complex network of nerves extending from neck to axilla supplying motor and sensory fibers of the upper extremity. Understanding the complexities of the formation and structure of the brachial plexus remains a cornerstone for effective regional anesthesia. On the level of supraclavicular fossa, the plexus is most compactly arranged. The supraclavicular approach of the brachial plexus has high success rate including blockade of the ulnar and musculocutaneus nerve, which can be missed respectively with the interscalene and axillary approach. However because of the close proximity of the pleura, most anesthesiologist has been reluctant to perform the supraclavicular approach. The introduction of ultrasound techniques not only reduces the possible risk of pneumothorax but also allows a faster onset time of the block with reduction of a local anesthetic dose. This makes supraclavicular approach a valuable alternative to the axillary, interscalene and infraclavicular approach for upper limb surgery.[5]

Many approaches to the brachial plexus have been described. Mainly, there are

four traditionally used techniques according to their anatomic locations where local anesthetics' are placed. These four important techniques of Brachial Plexus Block are:

- INTERSCALENE APPROACH, where local anesthetic drug is placed at the interscalene groove near the transverse processes of cervical vertebrae.
- SUPRACLAVICULAR APPROACH, when is block given at the subclavian sheath at the first rib.
- INFRACLAVICULAR APPROACH, drug is given near the coracoids process in the infra-clavicular fossa.
- AXILLARY APPROACH, when local anesthetic is injected surrounding the axillary artery in the axilla.[6]

Method

It was a prospective observational study carried out over a period of 18 month from November 2018 to April 2020 in the department of anesthesiology, Uttar Pradesh University of Medical Sciences (UPUMS), Saifai, Etowah, Uttar Pradesh. Patients aged between 18 to 65 years scheduled for elective upper limb orthopedic surgery were selected. All the patients were assessed for eligibility and were explained about the study protocol and the questions they were going to be asked in the postoperative period. Sample size 30 in each group. Informed and written consent was taken and a prospective, observational study was carried out on a total of 30 patients of sex, belonging to ASA grade I and II, between the age group 18 to 65 years, scheduled for elective upper limb orthopedic surgery, under supraclavicular brachial plexus block.

All patients were kept fasting for 6 hours before the procedure. On arrival of patient in the operating room, all the standard monitors were attached including non-invasive blood pressure (NIBP) cuff, pulse oximeter; three-lead ECG and the baseline parameters were recorded. Baseline perfusion index was taken in both the arms. An intravenous line with 18 G cannula was secured in the unaffected limb and intravenous crystalloid infusion was started. Premedication with injection ranitidine (50mg) IV and midazolam (0.03mg/kg) IV was given. The supraclavicular brachial plexus block was performed under guidance of a linear ultrasound transducer (sonosite 6-13MHz) 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. A22-gauge 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 local anesthetic (Ropivacaine0.5% 30 ml) was injected under vision strictly perineural to surround all the nerve cords. Time to deposit local anesthetic was considered as zero. The limb was evaluated for block success every 3 min for the sensory and motor block. Sensory function was assessed every three minute, using pinprick test using the blunt end of 26 gauge hypodermic needle in the dermatomal areas supplied by the four main nerves (median nerve, radial nerve, ulnar nerve, and musculocutaneous nerve), till the

onset of sensory block. Onset time of sensory block was defined as the time interval between the end of total local anesthetic administration and complete sensory block. Motor block was assessed every three minute, using modified Bromage scale, till the onset of motor block.

Onset time of motor block was defined as time interval between the end of local anesthetic administration and complete block. Scale 0 and 1 together was considered as block failure and scale 2 was considered as satisfactory block. The gold standard for unsuccessful block was the need for general anesthesia after 30 minutes of the block because of pain sensation at the site of the operation. The PI was measured using pulse oximetry applied on the index finger. The PI was recorded at baseline then every 3 min till sensory and motor block is achieved, after the local anesthetic injection, in both the blocked limb and the contra lateral unblocked limb using two separate oximeters. This unblocked limb was acting as control. Pain was assessed with visual analogue scale (VAS). When the VAS score ≥3, injection diclofenac 75mg intramuscular was given. The PI ratio was calculated as the ratio between the PI at every 3 min till sensory and motor block achieved after injection and the baseline PI. In every patient, a comparison between the blocked and unblocked limb was performed.

In all these patients, level of sedation was assessed every 15 min using Ramsay sedation scale. The hemodynamic variations- Heart rate, mean arterial blood pressure along with oxygen saturation was recorded at time zero; 5th; 10th; 15th; then every 15 min till the end of surgery. Assessment tools are 3 point scale, Modified Bromage scale; Visual analogue scale and Ramsay sedation scale. The collection data was analyzed by appropriate test of significance. The quantitative variables are expressed as mean±sd and compared using paired t-test. The data is stored in MS Excel spreadsheet and statistical analysis performed using open source 'R' programming language.

Inclusion criteria

- Age 18-65 years
- Patients of either sex scheduled to undergo elective upper limb surgeries.
- ASA grade I and II

Exclusion criteria

- Patients refusal
- Patient with allergy to local anesthetics
- Patients with local infection at the injection site
- Patients older than 65 year

Result

Table 1
Distribution of age among the study group

Years	n	%
≤ 20 Years	6	20.00%
21 – 30	5	16.67%
31 – 40	8	26.67%
41 – 50	4	13.33%
51 -60	6	20.00%
>60	1	3.33%
Total	30	100%

Table 1 shows the distribution of age among the study group. Majority of the patients are in the age group 31 - 40 years of age with a mean age of 37.37±15.01 years.

Table 2
Distribution of gender among the study group

Gender	n	%
Male	25	83.33%
Female	5	16.67%
Total	30	100%

Table 2 shows the distribution of gender among the study group. Numbers of males are more than females, i.e 83.33% of males and 16.67% of females.

Table 3
Distribution of quality of Block in the Study group

Quality	n	%
0	3	10.00%
2	27	90.00%
Total	30	100%

Table 3 shows quality of block among the study group.90% of the patient's attained successful block while 10% of the patients attained unsuccessful block.

Table 4
Perfusion Index Ratio in the blocked limb

PIR BLOCKED LIMB	Mean	±SD	P- Value(vs. 0mins)
0mins	1.00	±0	<0.001
3mins	1.21	±0.2	<0.001
6mins	1.53	±0.34	<0.001
9mins	1.75	±0.47	<0.001

12mins	1.88	±0.53	<0.001
15mins	1.94	±0.67	<0.001
18mins	1.90	±0.64	<0.001
21mins	1.87	±0.63	<0.001
24mins	1.85	±0.55	<0.001
27mins	1.83	±0.54	<0.001
30mins	1.83	±0.58	<0.001

Table 4 shows perfusion index ratio in the blocked limb. The PIR of blocked limb was initially value 1 at the baseline and rose significantly to reach 1.94±0.67 at 15 min ($p<0.001$). PIR increased steadily till the patient achieved successful block.

Table 5
Perfusion Index Ratio in the unblocked limb

PIR UNBLOCKED LIMB	Mean	±SD	P- Value(vs. 0mins)
0mins	1.00	±0	-
3mins	1.00	±0.02	0.075
6mins	1.00	±0.05	0.367
9mins	1.01	±0.04	0.065
12mins	0.99	±0.05	0.136
15mins	0.99	±0.03	0.041
18mins	0.99	±0.04	0.032
21mins	0.99	±0.03	0.010
24mins	0.99	±0.04	0.076
27mins	0.99	±0.02	0.035
30mins	1.00	±0.03	0.187

Table 5 shows perfusion index ratio in the unblocked limb. The PIR of unblocked limb was initially 1 at the baseline and remained more or less around the same level at all the subsequent time interval.

Table 6
Correlation of PIR of blocked limb with onset of sensory and motor block

PIR BLOCKED	MEAN	±sd	p- value
SENSORY BLOCK	1.86	±0.4	<0.001
MOTOR BLOCK	2.15	±0.61	<0.001

Table 6 shows correlation of PIR of blocked limb with onset of sensory and motor block. The mean PIR of blocked limb when sensory block is achieved was 1.86±0.4 and that of the onset of motor block is 2.15±0.61 (p-value < 0.001).

Discussions

OnurAvci et al studied ultrasound guided supraclavicular block with traditional methods and perfusion index on upper extremity surgeries in 30 volunteer

patients who were 18-75 years old with ASA I-II scores undergoing a hand, forearm, arm surgery by injecting local anesthetic that consists of prilocaine 12.5 ml + bupivacaine 12.5 ml to all patients, sensory block was checked with pin-prick test every 3 minutes, motor block was checked by using modified bromage scale every 2 minutes, hemodynamic parameters and PI values were recorded every 5 minutes. Times of motor block onset and total motor block onset, sensory and motor block ending time, the duration of block technique, the time of first postoperative analgesia consumption and positivity time for pin-prick test were recorded. When we compared the PI values in pairs, the differences between basal and 5th min, 10th min, 15th min, 20th min, 25th min, and 30th min were significant. In the 5th minute PI values, an average increase of 148% was observed compared to basal PI values.[7]

Klodell CT et al derived perfusion index for intraoperative identification of successful thoracic sympathectomy in 10 adult patients undergoing bilateral endoscopic thoracic sympathectomy under general anesthesia and finger pulse oximetry probes were placed on each hand, and reference probes on each earlobe, hemodynamic variables and PI were continuously monitored. A successful sympathectomy was defined by a twofold increase in PI on the ipsilateral arm. Data were analyzed with analysis of variance and Student's t tests; a $p < 0.05$ was considered significant. In their result they found that right sympathectomy was associated with a 372% increase in PI ($p < 0.0001$), and left sympathectomy with a 316% increase in PI ($p < 0.029$). This dramatic increase occurred as early as 1 minute after transaction of the sympathetic chain, and within 2 minutes in all cases. The increased PI rapidly approached its peak value, where it remained throughout the remainder of the procedure. This was consistent in both right and left sides.[8]

Sahin OF et al studied the importance of perfusion index monitoring in evaluating the efficacy of stellate ganglion blockage treatment in Reynaud's disease where in 40 patients, aged 18–65 years SGB was using 6 mL of 5% levobupivacaine at the 7th cervical vertebra level. The PI values were recorded from the distal end of the 2nd finger of the upper extremity on the side applied with the block and a 62.7% increase was observed from baseline to the first session at 5 min ($p < 0.05$) was observed, a statistically significant increase was determined in the PI values measured at 5, 15, 30, 60 and 120 min compared with the baseline values.[9]

Ceylan A et al evaluated success of supraclavicular blockade performed under general anesthesia in arthroscopic surgery of the shoulder by using perfusion index in which 50 patients aged between 18 and 60 years old and with ASA 1-2 risks and the PI was measured non-invasively with pulse-oximetry probe (Masimo Corp, Irvine, CA, USA) from the fingers at the same and opposite sides of blockade at the beginning, 5th, 10th, 20th, 30th minutes, postoperatively and in post anesthesia care unit (PACU and when compared to the initial PI change rate, the rates of change were found to increase significantly in the 5th, 10th and 20th minutes ($p<0.001$).[10]

Conclusion

In this study, we found PI as a simple, early, objective, noninvasive technique

with high specificity and sensitivity for assessing the success or failure of regional blocks as compared with conventional assessment of changes in sensation. PI significantly increased in blocked limb who received an effective block but not on unblocked limb. Hence we concluded PI as a useful tool for evaluation of successful supraclavicular nerve block. A PI ratio of ≥1.2140 is a good predictor for block success.

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