Comparison of Traditional Methods Versus Perfusion Index as A Reliable and Early Indicator of Success of Ultrasound Guided Supraclavicular Nerve Block- A Randomized Clinical Trial.

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BACKGROUND AND AIM: Ultrasound (USG) guided supraclavicular brachial plexus block in upper extremity surgeries is a popular approach. Traditional methods for evaluation of block success are time consuming and dependent on patient’s cooperation. The present study aims to evaluate the efficacy of USG guided supraclavicular block by perfusion index (PI) and perfusion index ratio over traditional methods in patients undergoing upper limb surgery. METHODS: Sixty patients of ASA grade I & II were randomly selected scheduled for upper limb surgery under USG guided supraclavicular block. All patients received injection ropivacaine 0.75% (2 mg/kg) with injection tramadol (100 mg) block. Sensory and motor block were assessed using Hollmen Scale with pin-prick test and modified Bromage scale respectively. PI values were recorded at baseline and after the block procedure. RESULTS: The mean time taken to obtain sensory and motor block was 7.03 ± 1.10 minutes and 12.23 ± 1.66 minutes respectively. The mean baseline PI value was 0.92 ± 0.38. which increased to 1.99 ± 0.69 at 5-minute interval and further increased to 3.02 ± 1.00 at 10-minute time interval which was almost triple from the mean baseline value. The mean perfusion index ratio was 3.40 ± 0.49. All the values were found to be highly significant with a p-value of 0.001. CONCLUSION: In comparison with traditional methods, perfusion index provides a rapid, simpler, consistent and an efficient method to predict the success or failure of USG guided supraclavicular nerve block.

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INTRODUCTION:
Supraclavicular brachial plexus block is a safer method for upper limb surgeries, providing a smooth transition to postoperative pain relief.[1] Application of ultrasound for block has improved the success rate with excellent localization of nerves and improved safety.[2]

The success of block can be determined by evaluation of sensory and motor functions. These tests are subjective, very time consuming, depend on patient’s clinical signs (increase in local temperature and loss of sensation) which could be ambiguous which may delay onset and do not adequately predict success/failure of block, patient’s cooperation and understanding of the process.[3] Therefore, a newer, faster and more reliable method i.e., perfusion index (PI) has been evolved to assess the success of supraclavicular block. It is the ratio of pulsating to non-pulsating blood flow measured by pulse oximeter.[4] It is a reflection of blood perfusion in peripheries.[5]

Primary aim of the current study was to determine perfusion index as an early and reliable method to assess the outcome, success or failure of ultrasound guided supraclavicular block and compare it with traditional methods of patient’s response to pin prick, cold sensation etc. Parameters like onset of sensory block and motor block, duration of sensory and motor block, time to first rescue analgesia and total number of doses of rescue analgesia were also noted.

Secondary aim of the study was to assess haemodynamic parameters and post-operative complications, in any.

MATERIALS AND METHODS:
The present prospective randomized study was approved by the institutional ethics committee and trial was registered in Clinical Trial Registry- India (CTRI/2022/12/048487). The study was conducted in 60 patients belonging to ASA grade I & II, aged 20-60 years scheduled for arm, forearm, elbow, wrist and hand surgeries under USG guided supraclavicular block. Written informed consent was taken from patients before enrolling in the study. Patients giving refusal to enlist in the study, with ASA Grade III and IV, coagulation disorder and on anticoagulation therapy, history of allergy to local anaesthetic, previous nerve damage and brachial plexus injury, partial block requiring supplementation and failed block requiring general anaesthesia were excluded from the study.

All patients were examined and pre-anaesthetic checkup was done a day before surgery. Patients were kept fasting 6 hours for solids and semisolids and 2 hours for clear fluids before surgery. Tablet alprazolam 0.5 mg was given a night before the surgery. On arrival in the operating room, an intravenous line was secured with 20G intravenous cannula and infusion with ringer lactate (RL) was started. Multi-parameter monitors were attached and heart rate (HR), blood pressure (BP), respiratory rate (RR), pulse oximetry (SpO₂) and electrocardiography (ECG) were monitored continuously both during intraoperative and postoperative period. Injection midazolam 0.01mg/kg was given before the surgery. In the OT, patient was made to lie supine with arms by the side and head turned away from the side to be blocked. Brachial plexus and the subclavian artery were visualized on ultrasound. Utilizing the in-plane approach, the block needle was advanced from lateral to medial aiming for the main neural cluster of the brachial plexus. After confirming negative aspiration, injection ropivacaine 0.75% in a dose of 2 mg/kg with injection tramadol 100 mg was injected. Subsequently small aliquots of 5mL of local anaesthetic were deposited near the surrounding satellite neural cluster after every negative aspiration and the data was recorded.

The onset and degree of sensory block was tested by using pin-prick test (using 22 G needle) and graded by Hollmen Scale (1 = Normal sensation of pin prick, 2 = Pin prick felt as sharp and pointed but weaker compared with the same area in other limbs, 3 = Pin prick recognized as touch with blunt object, 4 = No perception of pin prick). Onset and degree of motor block was assessed with modified Bromage's scale: 0 = no block (normal function with full flexion and extension of elbow, wrist, and fingers), 1 = paresis (decreased motor strength with ability to move fingers only), 2 = paralysis (complete motor block with inability to move fingers).[6] Sensory and motor block grading was recorded at baseline and then every 1 minute after completion of block procedure till 15
minutes followed by recording of grades every 5 minutes till 30 minutes. Onset of sensory block was taken as the time elapsed between the end of local anaesthetic injection and the time to achieve Hollmen scale grade 3 while onset of motor block was taken as the time elapsed between the end of local anaesthetic injection and the time taken to achieve modified Bromage's scale grade 2. Philips IntelliVue MX 500 monitor was used to record perfusion index at baseline, every 1 minute for next 15 minutes and thereafter every 5 minutes till 30 minutes after the block procedure. Perfusion index ratio was taken as the ratio of perfusion index value at 10-minutes time interval and baseline value.

30 minutes after establishment of the block, surgery was started and the time of beginning of surgery was noted. Systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), pulse rate (PR) and oxygen saturation (SpO$_2$) monitoring was also done both intra-operatively and post-operatively. In the post-operative period, if the Visual Linear Analogue Scale (VAS) was >3, rescue analgesia was given. Injection paracetamol 1g was given intravenously to the patients as rescue analgesia. Patients were observed for complications like convulsion, systemic toxicity, vessel puncture, pneumothorax, hematoma, phrenic nerve paralysis, laryngeal nerve paralysis, Horner syndrome and when detected, they were recorded.

**STATISTICAL ANALYSIS:**

Variation in perfusion index values after the block was taken as the primary outcome measure of interest for the purpose of sample size calculation. The sample size was calculated using the formula for single mean where the mean of perfusion index from previous studies was taken. The formula used was $N > (Z_{\alpha/2})^2 s^2/d^2$ where the power of the study was assumed to be 80% and standard deviation was taken to be 1.7 and error was taken to be 0.5. Based on this the minimum sample size was calculated to be 48 but keeping into account dropouts or exclusion, a total of 60 patients were included in the study. Data was recorded in a Microsoft excel spread sheet and analyzed using statistical package for the social sciences (SPSS version 24.00 Armonk, NY: IBM Corp.). Continuous data was presented as mean with standard deviation. Categorical data was expressed as percentages. The mean ± standard deviation of perfusion index at the baseline was compared with the subsequent time intervals using paired t-test using repeated measures ANOVA.

**OBEVATIONS AND RESULTS:**

![Consort Diagram](image-url)
In the current study, the baseline mean perfusion index was 0.92 ± 0.38. The minimum value at baseline was 0.30 while the maximum value at baseline was 1.90.

Table 1: Demographic Profile

<table>
<thead>
<tr>
<th>S. No</th>
<th>Parameter</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Age (years)</td>
<td>38.31 ± 12.23</td>
</tr>
<tr>
<td>2.</td>
<td>Weight (kg)</td>
<td>65.98 ± 5.85</td>
</tr>
<tr>
<td>3.</td>
<td>ASA Grade 1 (%)</td>
<td>60%</td>
</tr>
<tr>
<td>4.</td>
<td>ASA Grade 2 (%)</td>
<td>40%</td>
</tr>
<tr>
<td>5.</td>
<td>Male (%)</td>
<td>66.67%</td>
</tr>
<tr>
<td>6.</td>
<td>Female (%)</td>
<td>33.33%</td>
</tr>
</tbody>
</table>

Table 2: Time measurement for the block using traditional methods: pin prick and modified Bromage scale

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mean</th>
<th>SD</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of surgery (hours)</td>
<td>2.440</td>
<td>0.524</td>
<td>1.20</td>
<td>3.40</td>
</tr>
<tr>
<td>Time taken to perform the block (minutes)</td>
<td>4.533</td>
<td>1.040</td>
<td>3.00</td>
<td>7.00</td>
</tr>
<tr>
<td>Onset of sensory block (minutes) [Pin-Prick]</td>
<td>7.035</td>
<td>1.104</td>
<td>4.80</td>
<td>8.80</td>
</tr>
<tr>
<td>Onset of motor block (minutes) [Modified Bromage Scale]</td>
<td>12.235</td>
<td>1.664</td>
<td>9.20</td>
<td>15.40</td>
</tr>
<tr>
<td>Duration of sensory block (hours)</td>
<td>8.227</td>
<td>0.615</td>
<td>7.00</td>
<td>9.30</td>
</tr>
<tr>
<td>Duration of motor block (hours)</td>
<td>7.677</td>
<td>0.602</td>
<td>6.50</td>
<td>8.80</td>
</tr>
</tbody>
</table>

Table 3: Assessment of block by PI Ratio

<table>
<thead>
<tr>
<th>Time Interval (minutes)</th>
<th>Perfusion Index Ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>10 minutes</td>
<td>3.408</td>
<td>0.494</td>
</tr>
<tr>
<td>15 minutes</td>
<td>4.497</td>
<td>0.782</td>
</tr>
<tr>
<td>20 minutes</td>
<td>5.524</td>
<td>1.157</td>
</tr>
<tr>
<td>25 minutes</td>
<td>6.815</td>
<td>1.735</td>
</tr>
<tr>
<td>30 minutes</td>
<td>8.128</td>
<td>2.271</td>
</tr>
</tbody>
</table>

As shown in figure 2, there was a linear increase in the values of perfusion index from the baseline. All the values at subsequent time intervals were quite high as compared to baseline. At 5-minute interval, the average perfusion index value reached to 1.99 ± 0.69 which was almost double the value at baseline. At 10-
minute time interval, the mean value of perfusion index increased to 3.02 ± 1.00 which was almost triple from the mean baseline value. At all the time intervals, values of perfusion index obtained were statistically highly significant (p-value = 0.001).

As shown in figure 3, the value of perfusion index started rising as soon as 1 minute after the block procedure was complete. The onset of sensory block at i.e., grade 3 was achieved in all 60 patients after 8 minutes while the onset of motor block i.e., grade 2 was achieved by all 60 patients after 15 minutes thus emphasizing the fact that the perfusion index is a faster predictor of the block.

Figure 4: Based on the response of the patient, when the visual linear analogue scale (VAS) was >3, rescue analgesia was given Injection paracetamol 1g was given intravenously to the patients as rescue analgesia. Average number of total rescue analgesia doses required were 2.05 ± 0.428.

![Fig. 2: Perfusion Index](image)

![Perfusion Index vs Traditional Methods](image)
DISCUSSION:
In patients undergoing USG guided supraclavicular brachial plexus block, the efficacy of anaesthesia is evaluated by traditional methods like pin prick, temperature (cold/heat) test and/or loss of pain sensation and motor block test.[8] These tests are subjective, very time consuming and depend on patient’s cooperation. Therefore, using a newer and faster method i.e., perfusion index (PI) has been evolved to assess the success of supraclavicular block. It is the ratio of pulsating blood flow to non-pulsating blood flow in peripheral tissues measured by a special pulse oximeter. Peripheral vasodilation occurs in the extremity of the block and accordingly increases the perfusion in the same extremity. Thus, an increased perfusion index on the side of the block may be a reliable means to determine the efficacy of supraclavicular brachial plexus block. In the present study, after completion of block procedure, sensory and motor grading as well as perfusion index values were recorded. The sensory and motor block (by traditional methods) was achieved in a mean time of 7.03 ± 1.10 and 12.23 ± 1.66 minutes respectively while the mean duration of sensory and motor block was 8.22 ± 0.61 and 7.67 ± 0.62 hours respectively.

At the baseline, the mean perfusion index was 0.92 ± 0.38. After 5 minutes, the mean perfusion index value increased to 1.99 ± 0.69 which was almost double the value at baseline. At 10-minute time interval, the mean value of perfusion index increased to 3.02 ± 1.00. Here, the mean perfusion index value almost tripled from the mean baseline value. All the values were statistically highly significant with value of p = 0.001. At 10-minute time interval, the mean perfusion index ratio was 3.40 ± 0.49.

Similar results were seen in a study conducted by Galvin EM et al in 2006, stating that successful blocks are associated with an increase in PFI values compared with baseline, beginning as early as 3 minutes after local anaesthetic injection and reaching statistical significance at a time of 12 minutes and 10 minutes for sciatic and axillary blocks, respectively.[9] Similarly in 2017, a study conducted by Abdelnasser et al. on 77 patients with USG guided supraclavicular block found a persistent increase in the mean PI from baseline (2.8) up to 30 minutes (7.1) in the blocked arm.[7] They reported the cut-off value for PI at the tenth minute as 3.3 and PI ratio as 1.4. Consequently, in 2019, Raj RL et. al observed that PI value increased to (mean ± standard deviation) 8.50 ± 2.59 from baseline.[10] All changes were significant (p < 0.01)
concluding, perfusion index monitoring may provide a highly valuable tool to evaluate the success of regional anaesthesia of the upper extremity in clinical practice. In the year 2020, Avci O et al. also evaluated that the positivity time for pin-prick test was 8.83 ± 2.70 minutes, motor block onset time was 6.7 ± 2.89 minutes whereas in the 5th minute, an average increase of 148% was observed in PI values.[11] Our trial was also supported by Del Buono R et al in 2020, wherein after brachial plexus blocks, PI values tripled at 5 minutes after the block execution and increased linearly, reaching at 10 minutes an average PI value 3.8 times higher than baseline.[12] Eskin MB et al conducted a study in 2020 which resulted in a statistically significant increase in the perfusion index of the extremities in all patients after a brachial plexus blockade (p < 0.001).[13] Recently in 2021, Jatin Lal et al conducted a similar study reaching to the conclusion that mean PI increased continuously from baseline and reached the maximum at 10 minutes and in case of successful blocks, mean perfusion index starts increasing 2 minutes after the block further increasing linearly till 10 minutes. A cut-off value of 3.25 for perfusion index and 3.03 for perfusion index ratio showed a fairly good ability with high sensitivity and specificity for predicting the success of block.[14] LIMITATIONS:
1. Perfusion index was not recorded in the unblocked arm and hence no comparison could be made.
2. All the failed blocks and partial blocks were not included during result calculation.
3. We were unable to obtain sensitivity and specificity due to lack of inclusion of failed block.
4. Furthermore, degree of block success based on number of segments or nerves blocked should have been considered.
5. No additives like epinephrine or clonidine were used. Therefore, their possible impact on perfusion index could not be explored and cut off value could not be decided.

CONCLUSION:
As a result of our study, it was discovered that the perfusion index is a quicker and simpler method than traditional methods to determine success of an ultrasound-guided supraclavicular block. The advantage of the anaesthesiologist is that they can predict the block’s early success without relying on the patient's comprehension of the procedure.

REFERENCES:

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Conflict of Interest: None declared

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