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# Comparative study of nerve stimulator versus USG guided supraclavicular brachial plexus block: A randamized control trial

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**Abstract**
**Introduction:** The study contrasts peripheral nerve stimulator-guided and ultrasound-guided techniques for supraclavicular brachial plexus block in upper limb surgeries. Ultrasound guidance offers real-time nerve visualization and precise needle placement, reducing complications. Conversely, peripheral nerve stimulator methods may carry higher risks and lower success rates. By assessing success rates, complications, and patient satisfaction, the research aims to offer evidence-based recommendations for anesthesia practice. These findings contribute to refining techniques, enhancing patient safety, and optimizing surgical outcomes in regional anesthesia.
**Aims:** This study was carried out with the objective of comparing the Supraclavicular brachial plexus block by using Peripheral nerve stimulator and Ultrasound guided technique for upper limb surgeries.
**Objectives:** To compare
1. Block execution time
2. Time of onset of sensory and motor block
3. Time to achieve complete sensory and motor block
4. Duration of sensory and motor block
5. Success rate of block procedure
6. Incidence of complications
7. Time to first analgesic request

**Methodology:** This prospective, randomized trial consists of total 60 patient undergoing elective upper limb surgery. Informed consent from patients taken, involving thorough preoperative assessments of 60 adult patients meeting inclusion criteria. Inclusion criteria encompassed factors like normal sensory and motor functions, specific age range, ASA physical status, and surgery type. Exclusion criteria included contraindications such as allergies, pregnancy, and comorbidities. Pre-anesthetic checks, patient education, and consent procedures were meticulously performed. Patients were divided into two groups for ultrasound-guided and peripheral nerve stimulator-guided supraclavicular block techniques. Detailed operational protocols, including OT preparation and equipment setup, were adhered to. Hemodynamic monitoring and data collection included parameters like block execution time, onset and duration of blockade, success rates, complications, and time to analgesic request.
**Results:** Ultrasound-guided brachial plexus block demonstrated superior efficacy, including stable hemodynamics, quicker onset, prolonged duration, and fewer complications compared to peripheral nerve stimulator-guided technique in upper limb surgeries.
**Conclusion:** Ultrasound-guided supraclavicular brachial plexus block proves superior in efficiency, accuracy, and safety. Future advancements depend on balancing clinical benefits with equipment costs.

**Keywords:** Peripheral nerve stimulator, ultrasound-guided, supraclavicular brachial plexus block

## Introduction

The passage provides a thorough comparison between regional anesthesia, particularly brachial plexus blocks, and general anesthesia, highlighting the advantages of regional techniques in minimizing interference with normal bodily functions. Brachial plexus blocks, administered via various approaches, offer effective intraoperative anesthesia and extended postoperative analgesia, making them a preferred choice for upper limb surgeries. However this technique is also associated with risk of injury to surrounding structures especially vascular structures, nerves and pleura leading to pneumothorax. Kulenkampff [11] first described the classical supraclavicular approach to the brachial plexus in 1912.

To address these issues, modern techniques like ultrasound and peripheral nerve stimulation have been introduced [1], aiming to enhance accuracy and safety. Ultrasound-guided approaches, in particular, offer real-time visualization and precise needle guidance, potentially reducing complications and improving outcomes [2, 4]. This study intends to compare peripheral nerve stimulator-guided and ultrasound-guided techniques for supraclavicular brachial plexus block, recognizing the potential advantages of ultrasound in terms of safety and efficacy [12].

By evaluating parameters like block execution time, success rates, and complication incidence, this research aims to provide evidence-based insights into the optimal technique for upper limb surgeries [8]. Ultimately, the findings could inform anesthesia practices, promoting safer procedures and better patient outcomes. This comparative analysis reflects the ongoing evolution of anesthesia techniques, driven by advancements in imaging technology and a commitment to enhancing patient care.

## Aims and objectives of study

This study aimed to compare the effectiveness of Supraclavicular brachial plexus block using peripheral nerve stimulator and ultrasound guidance for upper limb surgeries across several key parameters. Firstly, the block execution time was measured from preparation to confirmation. Secondly, the time to onset of sensory and motor block after completing the procedure was recorded. Thirdly, the duration to achieve complete sensory and motor block was noted. Additionally, the duration of sensory and motor block from onset to resolution was documented. The success rate of each technique in achieving adequate block for surgery without supplementation was calculated and compared. Complications, including nerve injury, hematoma, and pneumothorax, were monitored to assess the safety profile of each technique. Finally, the time interval until the first analgesic request post-surgery was measured to evaluate the efficacy of pain management. These parameters provided comprehensive insights into the comparative outcomes of the two techniques, aiding in clinical decision-making regarding the choice of Supraclavicular brachial plexus block method for upper limb surgeries.

## Materials and Methods

### Design: Randamized control trial

This randomized controlled trial aims to compare ultrasound-guided supraclavicular block (Group I) versus peripheral nerve stimulator (NS)-guided block (Group II) for below-shoulder upper limb surgeries. Eligible patients (18-60 years, ASA I & II, 40-70 kg) will undergo either technique based on random assignment. Group I utilizes a linear ultrasound probe for real-time visualization and injection of local anesthetic, while Group II employs a nerve stimulator to identify nerve proximity and confirm needle placement through motor responses. Key outcomes include block execution time, onset and duration of sensory and motor blockade, success rates, incidence of complications (local and systemic), and time to first analgesic request. Statistical analysis will compare these parameters using appropriate tests with significance set at $p<0.05$. Findings will inform clinical practice regarding the preferred technique for supraclavicular blocks, balancing efficacy and safety considerations in elective upper limb surgeries.

### Complications

Patients were observed for complications like.

**Local complications:** Vessel puncture (hematoma).

### Systemic Complications

Pneumothorax, Cardiotoxicity, Breathlessness/Tachypnoea, Horner's syndrome, other neurological sequel toxicity

## Results

Study of 60 cases of supraclavicular brachial plexus block was done in two groups (Each group contains 30 patients)

**Group I:** Ultrasound guided method and

**Group II:** Peripheral nerve stimulator method

Observation and results are summarized in tabulated form and described below.

**Table 1:** Demographic variables

| Variables | Group I | Group II | P value | Inference |
|---|---|---|---|---|
| Age (Year) | 34.8±9.6 | 35±9.8 | > 0.05 | NS |
| Sex (M:F) | 20:10 | 18:12 | > 0.05 | NS |
| Weight (kg) | 57.8±5.7 | 60.4±6.3 | > 0.05 | NS |
| ASA (I:II) | 20:10 | 20:10 | > 0.05 | NS |

Table 1 shows no significant difference between both groups as regard of age, sex, body weight and ASA grade. Where age and weight were analyzed using unpaired t-test, sex and ASA grading were analyzed using chi square test. As $p>0.05$, it was statistically non-significant.

**Table 2:** Characteristics of block

| Parameter | Group I | Group II | P-Value | Inference |
|---|---|---|---|---|
| Block execution time (min) | 4.13±1.04 | 7.63±1.12 | < 0.0001 | S |
| Onset of sensory blockage (min) | 2.7±0.98 | 6.03±0.80 | < 0.0001 | S |
| Onset of motor blockage (min) | 5.9±1.39 | 11.26±0.82 | < 0.0001 | S |

Table 2 shows block execution time, onset of sensory as well as motor blockade were shorter in group I compared to group II. And was statistically significant.

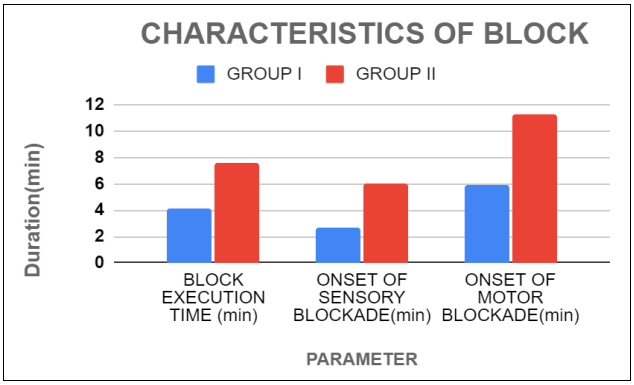


**Fig 1:** Comparison of block execution time between ultrasound-guided and peripheral nerve stimulator-guided techniques

**Table 3:** Time to achieve complete block

| Parameter | Group I N=29 | Group II N=28 | P-Value | Inference |
|---|---|---|---|---|
| Time to achieve complete block (MIN) | 12±1.16 | 17.1±0.95 | <0.0001 | S |

Table 3 shows time to achieve complete block was shorter in group I than group II and was statistically significant.

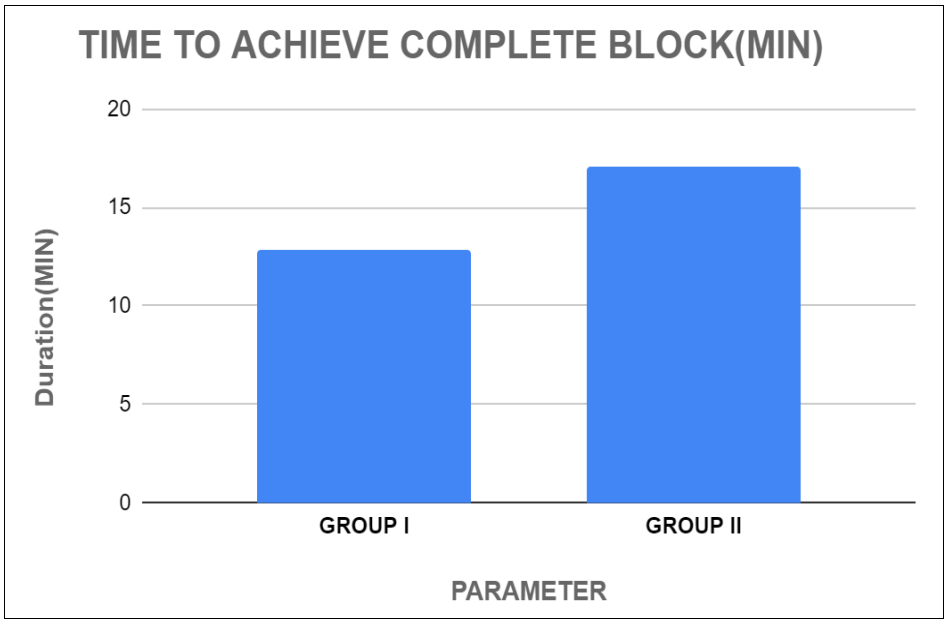


**Fig 2:** Onset time of sensory and motor block for ultrasound-guided and peripheral nerve stimulator-guided techniques

**Table 4:** Success rate of the block

| Assessment of block | Group I | Group II | P-Value | Inference |
|---|---|---|---|---|
| Successful | 29 | 28 | >0.05 | NS |
| Failed | 1 | 2 | | |

Table 4 shows failure of block resulted in 1 patient in group I and 2 patients in group II and were supplemented with general anesthesia. (P-Value using chi square test was >0.05, NS-Non significant).

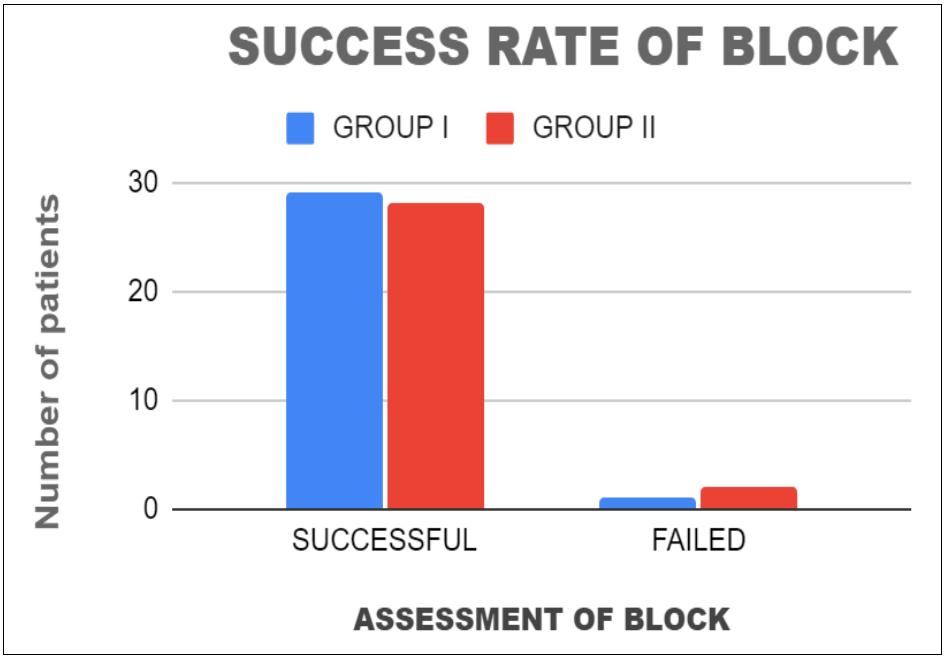


**Fig 3:** Success rate of block procedures using ultrasound-guided and peripheral nerve stimulator-guided techniques

Table 5 shows no significant difference in perioperative heart rate and systolic as well as diastolic blood pressure between both groups (p>0.05) (NS-Non-significant).

**Table 5:** Perioperative changes in heart rate and blood pressure

| Time (Min) | Heart Rate (Per Min) | | Blood Pressure (mmhg) | | | | P-Value |
|---|---|---|---|---|---|---|---|
| | Group I | Group II | Group I | | Group II | | |
| | Mean ± SD | Mean ± SD | SBP | DBP | SBP | DBP | |
| PRE-OP | 86.3±6.3 | 86.1±7.7 | 122.5±6.4 | 78.2±4.3 | 124.8±7.3 | 79.2±5.8 | NS |
| Immediate after block | 90.7±5.9 | 91.4±7.3 | 127±6.1 | 79.9±4.7 | 128.8±6.1 | 81.4±4.8 | NS |
| 5 min | 86.6±4.9 | 89.4±7.2 | 123±5.1 | 77.7±5.4 | 122.2±6.7 | 79.2±5.7 | NS |
| 10 min | 84.2±5.3 | 87.3±7.2 | 120.6±6.3 | 76.4±4 | 121.1±6.9 | 76.6±4.6 | NS |
| 15 min | 82.7±6 | 85.8±6.7 | 120.3±5.8 | 77.4±4.7 | 119.9±6.1 | 76.2±3.7 | NS |
| 30 min | 82.2±4.6 | 83.7±6.7 | 120.4±6.1 | 78.4±3.8 | 120.8±4.9 | 76.2±5.4 | NS |
| 60 min | 80.8±5.2 | 81.9±6.7 | 119.7±6.4 | 78.2±4.3 | 118.7±4.9 | 76.6±5.9 | NS |
| 90 min | 80.6±4.6 | 81.5±5.8 | 120.7±6.2 | 78.2±4.2 | 119.4±5.1 | 76.1±5.2 | NS |
| 120 min | 80.9±4.9 | 80.6±6 | 119.3±5.5 | 79.1±4.4 | 119.1±5.7 | 78.3±5.8 | NS |
| 150 min | 80.9±4.8 | 82.2±5.8 | 120.8±5.6 | 79.4±5 | 118.1±5.5 | 78.6±6 | NS |
| 180 min | 81.4±5 | 83.7±5.9 | 121.1±6.25 | 80.4±4.7 | 119.5±6.4 | 78.7±5.6 | NS |
| 210 min | 83.4±5.5 | 85.3±5.9 | 121.7±6.4 | 79.9±4.6 | 123.5±6.4 | 80.2±5.7 | NS |
| 240 min | 85.8±4.2 | 87.7±4.8 | 123.2±7 | 79.9±4.9 | 125.1±7.8 | 79.8±6.4 | NS |
| 270 min | 88.2±3.6 | 91.3±1.1 | 127.5±5.2 | 81±4.7 | 133.3±3 | 79.3±6.4 | NS |
| 300 min | 86.8±5.9 | 83±12.7 | 128.2±5.3 | 82±5.1 | 135±1.4 | 83±1.4 | NS |

**Table 6:** Perioperative respiratory rate and $SPO_2$ changes

| Time (min) | Respiratory rate (per min) | | SPO2 (In %) | | P-Value |
|---|---|---|---|---|---|
| | Group I | Group II | Group I | Group II | |
| | Mean ±SD | Mean ± SD | Mean ± SD | Mean ± SD | |
| Pre-OP | 16.2±1.1 | 15.9±1.4 | 98.6±0.6 | 98.7±0.4 | NS |
| Immediate after block | 16.6±1.1 | 16.2±1.1 | 98.7±0.5 | 98.8±0.3 | NS |
| 5 min | 16.7±1 | 16.3±1.1 | 98.8±0.4 | 98.8±0.3 | NS |
| 10 min | 16±1.2 | 15.8±1.3 | 98.9±0.4 | 98.8±0.4 | NS |
| 15 min | 16.1±1.3 | 15.9±1.4 | 98.9±0.3 | 98.8±0.4 | NS |
| 30 min | 16.6±1.2 | 16.1±1.1 | 98.8±0.3 | 98.8±0.3 | NS |
| 60 min | 16.2±1.1 | 15.9±1.4 | 98.9±0.3 | 98.8±0.3 | NS |
| 90 min | 16.1±1.3 | 15.8±1.4 | 98.8±0.2 | 98.8±0.3 | NS |
| 120 min | 16±1.2 | 15.8±1.3 | 98.8±0.3 | 98.8±0.3 | NS |
| 150 min | 16.2±1.5 | 15.9±1.2 | 98.8±0.3 | 98.8±0.3 | NS |
| 180 min | 15.8±1.4 | 16.1±1.3 | 98.8±0.3 | 98.8±0.3 | NS |
| 210 min | 16.1±1.4 | 15.9±1.3 | 98.9±0.3 | 98.8±0.4 | NS |
| 240 min | 16±1.3 | 16±1.5 | 98.8±0.3 | 98.8±0.3 | NS |
| 270 min | 16.1±1.5 | 15.6±0.5 | 98.9±0.2 | 98.6±0.5 | NS |
| 300 min | 15.8±0.6 | 15.5±0.7 | 98.8±0.3 | 98. 5±0.7 | NS |

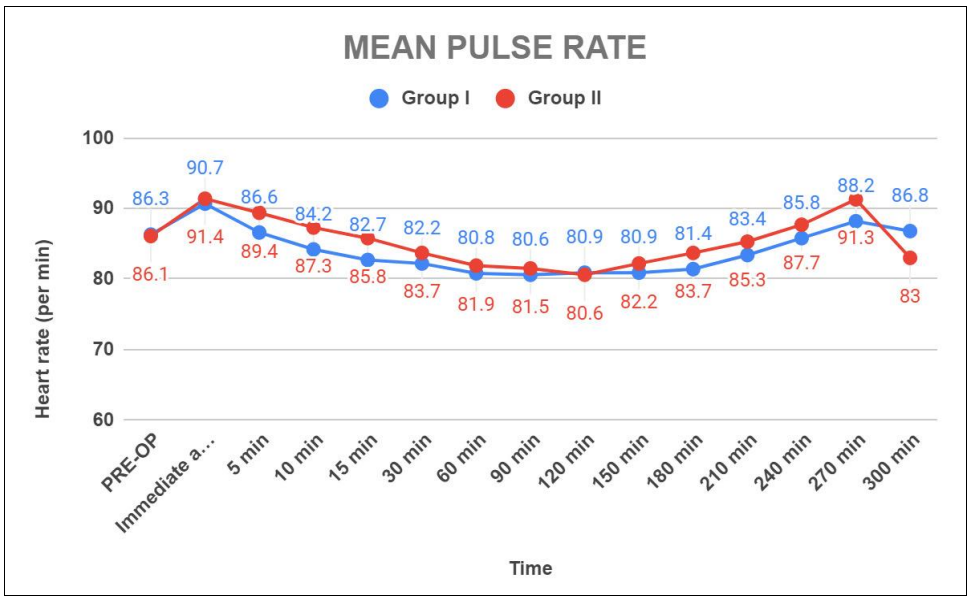


**Fig 4:** Perioperative changes in heart rate and blood pressure for ultrasound-guided and peripheral nerve stimulator-guided techniques

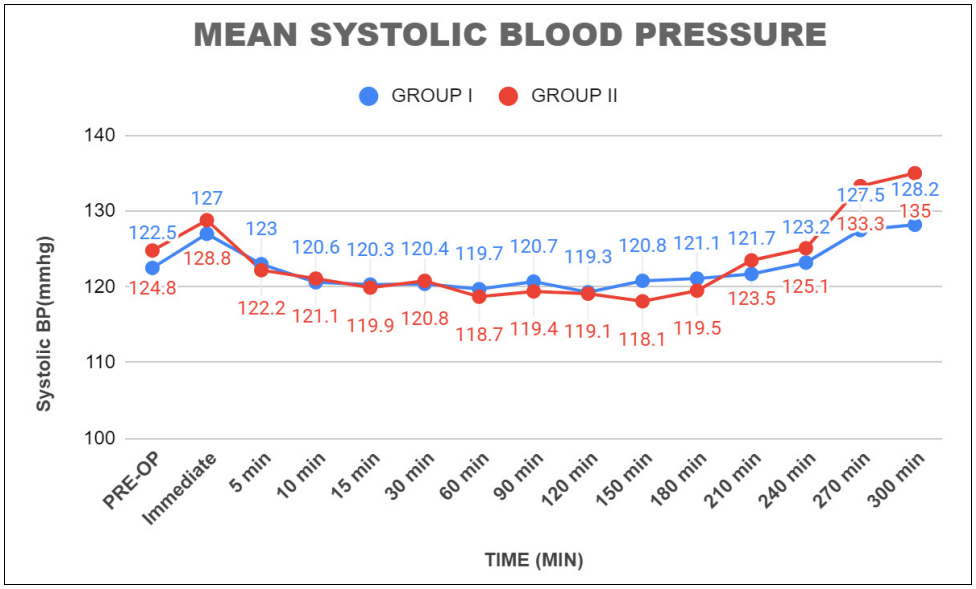


**Fig 5:** Perioperative respiratory rate and $SpO_2$ changes for ultrasound-guided and peripheral nerve stimulator-guided techniques

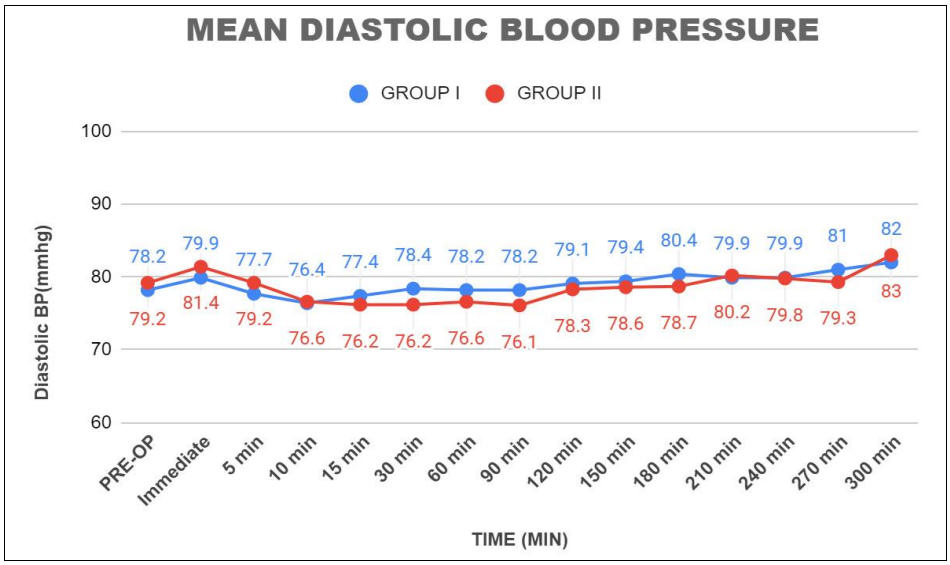


**Fig 6:** Comparison of surgery duration between ultrasound-guided and peripheral nerve stimulator-guided techniques

That there was no significant difference in perioperative Respiratory rate and $SPO_2$ between both groups ($p>0.05$), (NS-Non-significant).

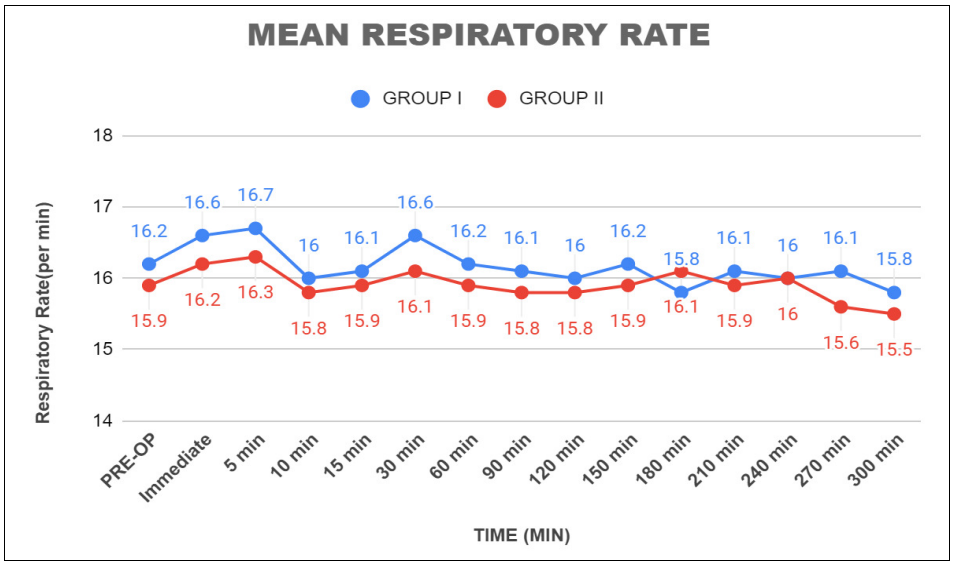


**Fig 7:** Perioperative respiratory rate and $SpO_2$ changes for ultrasound-guided and peripheral nerve stimulator-guided techniques

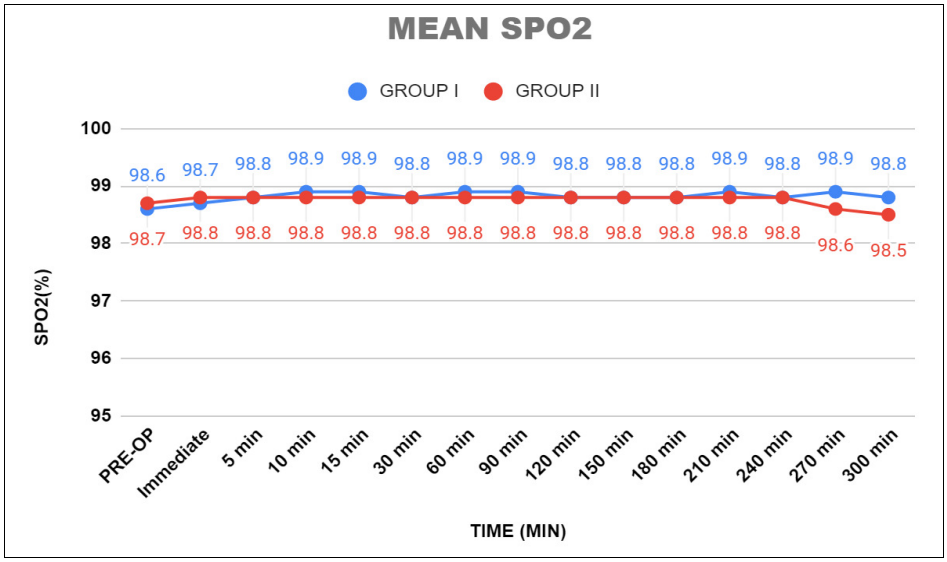


**Fig 8:** Perioperative respiratory rate and $SpO_2$ changes for ultrasound-guided and peripheral nerve stimulator-guided techniques

**Table 7:** Duration of surgery

| | Group I | Group II | P value | Inference |
|---|---|---|---|---|
| Duration of surgery (Min) | 98±25.91 | 90.66±17.20 | >0.05 | NS |

There was no significant difference between duration of surgery in both groups (p>0.05, NS-Non significant).

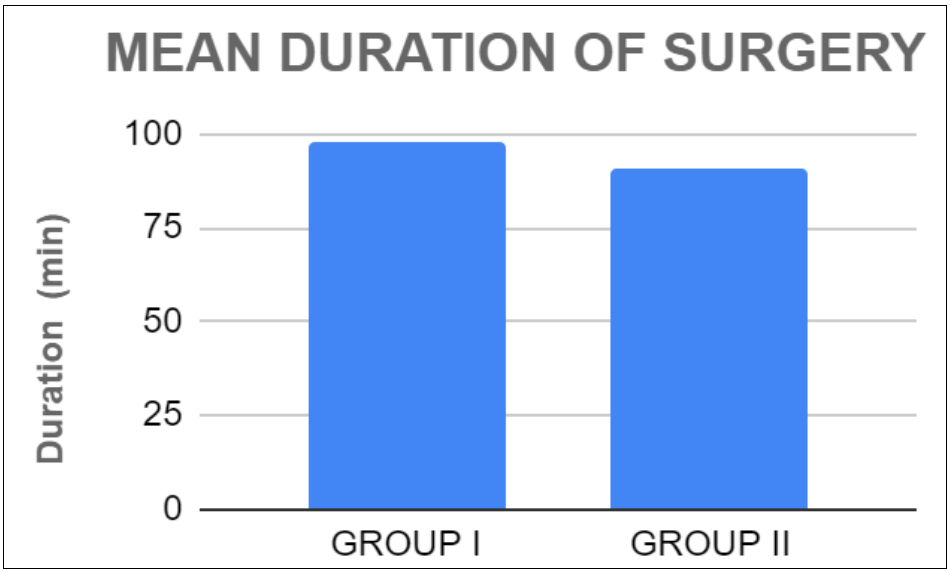


**Fig 9:** Complications observed in ultrasound-guided and peripheral nerve stimulator-guided techniques

**Table 8:** Duration of anesthesia and analgesia

| Time (min) | Group I (N=29) | Group II (N=28) | P-Value | Inference |
|---|---|---|---|---|
| Duration of motor block | 193.75±18.46 | 172.96±14.76 | <0.0001 | S |
| Duration of sensory block | 228.20±18.47 | 198.85±21.7 | <0.0001 | S |
| Time to 1st analgesic request | 268.27±19.33 | 243±23.84 | <0.0001 | S |

In group I one patient and in group II two patients required general anaesthesia number of patients for further study are respectively N=29 and N=28 for group I and group II. This table shows that mean duration of sensory block and motor block and time to 1st analgesic request are significantly longer in group I as compared to group II (p<0.0001).

**Table 9:** Complications

| Complications | Group I (N=30) | Group II (N=30) |
|---|---|---|
| Vessel Puncture | 0 | 2 |
| Horner's syndrome | 0 | 0 |
| Pneumothorax | 0 | 0 |
| Neurological sequelae | 0 | 0 |

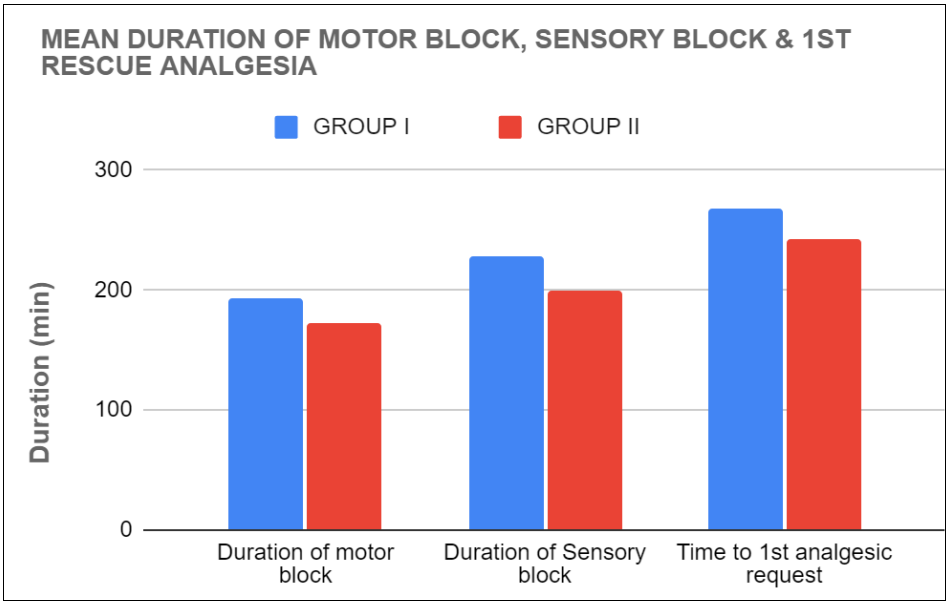


**Fig 10**: Duration of anesthesia and analgesia between ultrasound-guided and peripheral nerve stimulator-guided techniques

## Discussion

The study compared ultrasound-guided (USG) and peripheral nerve stimulator-guided techniques for supraclavicular brachial plexus block in 60 patients undergoing upper limb surgeries. USG offered real-time visualization, precise needle placement, reduced local anesthetic volume, and enhanced sensory and motor blockade onset. It demonstrated superior effectiveness in blocking distal sensory areas due to accurate nerve targeting and observed local anesthetic spread. In contrast, peripheral nerve stimulator guidance relied on electrical nerve stimulation for needle placement. The study aimed to determine which technique provided better outcomes in terms of efficacy, safety, and procedural advantages for anesthesia, highlighting USG's potential benefits in modern nerve block procedures.

### Demographic variables

Both groups were comparable with respect to age, gender, weight and ASA grade of the patients and found to be statistically non-significant (p>0.05).

### Hemodynamic parameters

In our study both groups were comparable in terms of heart rate, systolic and diastolic blood pressure, respiratory rate and oxygen saturation of the patients. No significant difference was found between two groups. (p>0.05).

Our data correlated with studies done by M Veeresham *et al.* (2018) [2] Anupriya, *et al.* (2020) [3].

### Block execution time

The mean block execution time was significantly less in Group I 4.13±1.04 minutes as compared to Group II, 7.63±1.13 minutes. (p<0.0001) Williams SR, *et al.* (2003) [5] also found that the average procedure time was 5.0 minutes in US guided group and in the peripheral nerve stimulator guided group it was 9.8 minutes for supraclavicular brachial plexus block. Mani KV, *et al.* (2017) [6] found that mean time required for performing ultrasound guided technique was 2.58 minutes and for PNS it was 5.82 minutes.

The possible reasons for the less time taken in performing US guided technique could be due to direct visualization of the structures and accuracy of needle placement. The less time taken to perform the procedure can also be attributed to a fair amount of expertise and readiness with all the equipment and drugs as and when needed 7.

### Onset of sensory and motor block

The mean onset time for sensory and motor block was found significantly less for Group I, 2.7±0.99 minutes and 5.9±1.4 minutes as compared to Group II, 6.03±0.81 minutes and 11.27±0.83 minutes respectively. (p<0.0001).

Rupera KB, *et al.* (2013) [7] also found that onset time of sensory and motor block was 2.97±0.72 minutes and 4.55±0.78 minutes in US group and in NS group, it was 3.63±0.76 minutes and 5.13±0.71 minutes.

### Time to achieve complete block

In our study, we found that time to achieve complete block was 12.83±1.17 minutes in Group I which was shorter as compared to 17.11±0.96 minutes in Group II (p<0.0001).

Rupera KB, *et al.* (2013) [7] also found that time to achieve complete block was 13.17±1.54 min in Group IS and 16.96±1.83 min in group PNS (p<0.0001).

### Success rate of block

The block was successful in 96.6% of patients in Group I compared to 93.3% in group II. These were comparable both clinically and statistically. This was not statistically significant (p>0.05).

Sarath surendran, *et al.* (2022) [8] also found that the block was 93.3% successful in USG guided technique, compared to 83.3% success rate in the PNS method.

### Duration of sensory and motor block

Intensity of postoperative pain was evaluated using visual analogue scale. VAS is the easiest and most commonly used tool for assessment of pain. The scale consists of a ruler with markings from 0 to 10. The patient is asked to state their present perception of pain, assuring 0 to be no pain at all and 10 to be the worst possible pain they could imagine.

In our study, the mean duration of sensory and motor block was 228.21±18.47 minutes and 193.76±18.47 minutes in group I was found significantly prolonged compared to

198.86±21.74 minutes and 172.96±14.76 minutes in group II. (p<0.0001).
Rupera KB, *et al.* (2013) [7] found that mean duration of sensory and motor block in US group was 5.29±0.82 hours and 5.05±0.67 hrs. and in PNS group, it was 4.73±0.81 hours and 4.58±0.73 hours.

**Time to first analgesic request**
The duration of analgesia in our study was 268.28±19.33 minutes and 243.03±23.85 minutes in the groups I and II, respectively. This was statistically significant (p<0.0001).
William SR *et al.* (2003) [4] also conducted similar study using the same drug combination and the duration was 846±531 min and 652±473 min in the groups US and NS, respectively.
Raghove P, *et al.* (2016) [8] found that duration of analgesia in Group USG was 312±54 min and in blind group it was 232±47 min.

**Complications**
No major complications related to drugs like nausea, vomiting, bradycardia, and hypotension and to procedures like pneumothorax, breathlessness were noted in both groups intraoperatively.
In Group I not a single complication was identified compared to Group II; in which incidence of vessel puncture was 10%.
Ratnawat A, *et al.* (2016) [9] also found no complications in US group as compared to group PNS; in which incidence of vessel puncture was 10%.
Sarath surendran, *et al.* (2022) [7] also found no complications in US group as compared to group PNS in which incidence of vessel puncture was 6.7%.
Kapral S, *et al.* (1994) [10] observed no complications such as pneumothorax, puncture of a major blood vessel, paresis, or irritation of the plexus, the recurrent laryngeal nerve, or the phrenic nerve in his study of ultrasound guided supraclavicular approach brachial plexus blockade.

**Conclusion**
It was concluded that the ultrasound guided supraclavicular brachial plexus block is more efficient, accurate and safer in terms of block execution time, onset and duration of sensory and motor block, time to achieve complete block, success rate, time to 1st analgesic request and incidence of complications. The use of newer imaging techniques has been described as “critically important to the future” of regional anaesthesia, the future of ultrasound guided blocks will depend in part on whether or not the clinical benefits associated with imaging technology justify equipment acquisition costs.

**Financial support and sponsorship:** Nil

**Conflict of Interest:** Nil

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