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Original Research Article

Comparison of Nerve Stimulator–Guided Technique and Ultrasound-Guided Supraclavicular Brachial Plexus Block in Upper Limb Surgeries: An Observational Cross-Sectional Study

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Abstract:

Background: Supraclavicular brachial plexus block is a commonly used regional anesthetic technique for upper limb surgeries. Traditionally performed using a nerve stimulator, the introduction of ultrasound guidance has improved block accuracy, success rates, and safety. However, comparative data from observational settings remain valuable in routine clinical practice.

Objectives: To compare nerve stimulator–guided and ultrasound-guided supraclavicular brachial plexus block with respect to block characteristics, success rate, complications, and patient satisfaction.

Methods: This observational cross-sectional study was conducted at RIMS, Ranchi, over one year. Seventy-two patients undergoing elective upper limb surgery were included and allocated into two groups based on the technique used: nerve stimulator group (NS group, n = 36) and ultrasound-guided group (US group, n = 36). Primary outcomes included block success rate, onset time of sensory and motor block, and duration of analgesia. Secondary outcomes included complications and patient satisfaction. Statistical analysis was performed using Student's t-test and Chi-square test.

Results: Ultrasound guidance resulted in significantly faster sensory block onset (9.6 ± 2.4 vs 14.8 ± 3.2 minutes) and motor block onset (12.1 ± 2.8 vs 18.2 ± 3.9 minutes), higher block success rate (97.2% vs 86.1%), and fewer complications compared to nerve stimulator guidance ($p < 0.05$).

Conclusion: Ultrasound-guided supraclavicular brachial plexus block offers superior block quality, faster onset, and improved safety compared to nerve stimulator–guided technique.

Keywords: Supraclavicular block, ultrasound guidance, nerve stimulator, regional anesthesia, upper limb surgery.

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Introduction

Regional anesthesia plays a pivotal role in modern anesthetic practice, particularly for upper limb surgeries, owing to its ability to provide effective anesthesia, prolonged postoperative analgesia, and reduced opioid consumption. Among the brachial plexus approaches, the supraclavicular block is often

referred to as the “spinal anesthesia of the upper limb” due to its dense and predictable blockade [1].

Traditionally, supraclavicular brachial plexus blocks were performed using landmark-based or nerve stimulator–guided techniques. While nerve stimulator guidance improved block success compared to landmark techniques, it remains an indirect method that relies on motor response rather than direct visualization of neural structures [2,3]. This may lead to variable block success, multiple needle passes, and increased risk of complications such as pneumothorax or vascular puncture [4].

The advent of ultrasound guidance has revolutionized regional anesthesia by allowing real-time visualization of nerves, surrounding structures, and spread of local anesthetic [5,6]. Several studies have demonstrated that ultrasound-guided brachial plexus blocks improve block success rate, reduce onset time, and minimize complications [7–9]. Additionally, ultrasound guidance may reduce local anesthetic volume requirements and enhance patient comfort [10].

Despite growing evidence supporting ultrasound guidance, nerve stimulator–guided techniques are still widely practiced, especially in resource-limited settings. Comparative observational data reflecting routine clinical practice remain relevant for understanding real-world outcomes [11].

This study was undertaken to compare nerve stimulator–guided and ultrasound-guided supraclavicular brachial plexus blocks with respect to block characteristics, success rate, and safety profile in patients undergoing upper limb surgeries.

Materials and Methods

Study Design and Setting: This observational cross-sectional study was conducted at Rajendra Institute of Medical Sciences (RIMS), Ranchi, over a period of one year starting from 02/03/2024.

Study Population: Seventy-two adult patients (ASA physical status I–II), aged 18–60 years, scheduled for elective upper limb surgeries under supraclavicular brachial plexus block were included.

Group Allocation: Patients were allocated into two groups based on the block technique used:

- **Group NS (n = 36):** Nerve stimulator–guided supraclavicular block
- **Group US (n = 36):** Ultrasound-guided supraclavicular block

Block Technique: Both groups received 20–25 ml of 0.5% bupivacaine under aseptic precautions. In Group NS, a peripheral nerve stimulator was used to elicit distal motor response. In Group US, a high-frequency linear ultrasound probe was used to visualize the brachial plexus and guide needle placement.

Outcome Measures

- **Primary outcomes:**
    - Onset time of sensory block
    - Onset time of motor block
    - Block success rate
    - Duration of analgesia
- **Secondary outcomes:**
    - Complications (vascular puncture, pneumothorax, Horner’s syndrome)
    - Patient satisfaction score

Statistical Analysis: Data were analyzed using SPSS software. Continuous variables were analyzed using Student’s t-test and categorical variables using Chi-square test. A p-value <0.05 was considered statistically significant.

Results

A total of 72 patients scheduled for upper limb surgeries were included in the study. Patients were allocated into two groups based on the technique used for supraclavicular brachial plexus block: Group NS (Nerve Stimulator–guided block, n = 36) and Group US (Ultrasound-guided block, n = 36). All patients completed the study protocol and were included in the final analysis. There were no dropouts or protocol deviations (Figure 1).

Baseline Demographic and Surgical Characteristics: The demographic variables including age, sex, body mass index (BMI), ASA physical status, and duration of surgery were comparable between the two groups. No statistically significant differences were observed, indicating appropriate group matching (Table 1).

Table 1: Demographic and Clinical Characteristics

Parameter	Group NS (n=36)	Group US (n=36)	p value
Age (years)	39.8 ± 10.4	41.2 ± 9.7	0.54
Gender (M/F)	22 / 14	21 / 15	0.81
BMI (kg/m²)	24.7 ± 3.2	24.1 ± 3.0	0.42
ASA I / II	20 / 16	19 / 17	0.83
Duration of surgery (min)	78.6 ± 12.3	76.9 ± 11.8	0.56

Block Performance Characteristics: The block performance time was significantly shorter in the ultrasound-guided group compared to the nerve stimulator group (p < 0.001). Additionally, the

number of needle redirections was significantly lower in Group US, reflecting improved procedural efficiency (Table 2).

Table 2: Block Performance Parameters

Parameter	Group NS	Group US	p value
Block performance time (min)	9.6 ± 2.1	5.8 ± 1.4	<0.001
Needle redirections (number)	4.2 ± 1.3	1.6 ± 0.8	<0.001

Onset Time of Sensory and Motor Block: The onset of both sensory and motor block was significantly faster in the ultrasound-guided group compared to the nerve stimulator group ($p < 0.001$). This difference was consistent across all dermatomes assessed (Table 3, Figure 2).

Table 3: Onset Time of Block (minutes)

Parameter	Group NS	Group US	p value
Sensory block onset	14.8 ± 3.2	9.6 ± 2.4	<0.001
Motor block onset	18.2 ± 3.9	12.1 ± 2.8	<0.001

Block Success Rate: Block success was defined as the ability to proceed with surgery without the need for supplemental analgesia or conversion to general anaesthesia. The success rate was significantly higher in Group US (97.2%) compared to Group NS (86.1%) ($p = 0.04$) (Table 4).

Table 4: Block Success Rate

Outcome	Group NS	Group US	p value
Successful block	31 (86.1%)	35 (97.2%)	0.04
Failed / inadequate block	5 (13.9%)	1 (2.8%)	

Duration of Analgesia: The duration of postoperative analgesia was significantly prolonged in the ultrasound-guided group compared to the nerve stimulator group ($p < 0.001$) (Table 5).

Table 5: Duration of Analgesia

Parameter	Group NS	Group US	p value
Duration of analgesia (hours)	6.4 ± 1.5	9.1 ± 1.8	<0.001

Complications and Adverse Events: The incidence of complications was higher in the nerve stimulator group. Vascular puncture occurred more frequently in Group NS, whereas no cases of pneumothorax or local anesthetic systemic toxicity were observed in either group. The overall complication rate was significantly lower in the ultrasound-guided group (Table 6).

Table 6: Complications and Adverse Events

Complication	Group NS (n)	Group US (n)
Vascular puncture	6	1
Paresthesia	5	2
Hematoma	3	1
Pneumothorax	0	0
Local anesthetic toxicity	0	0

Patient Satisfaction: Patient satisfaction scores assessed postoperatively using a 5-point Likert scale were significantly higher in Group US compared to Group NS ($p < 0.001$) (Figure 3).

Figures

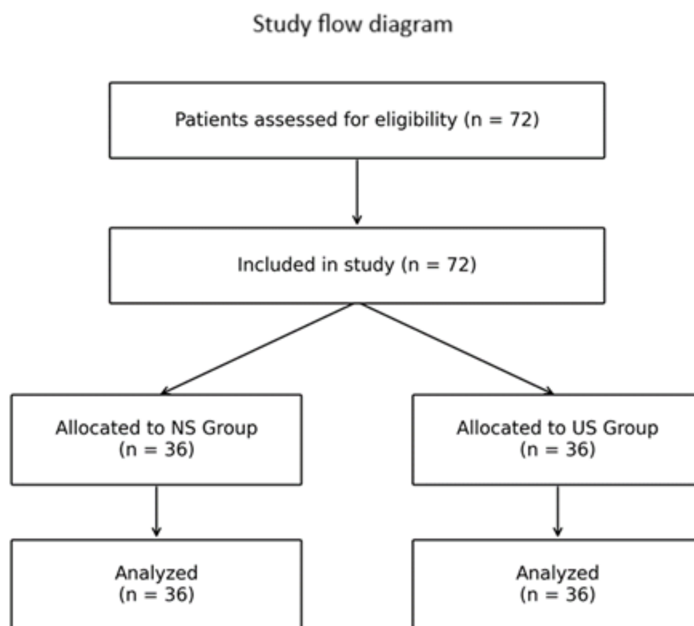

Figure 1: Study flow diagram showing patient enrollment, allocation, and analysis

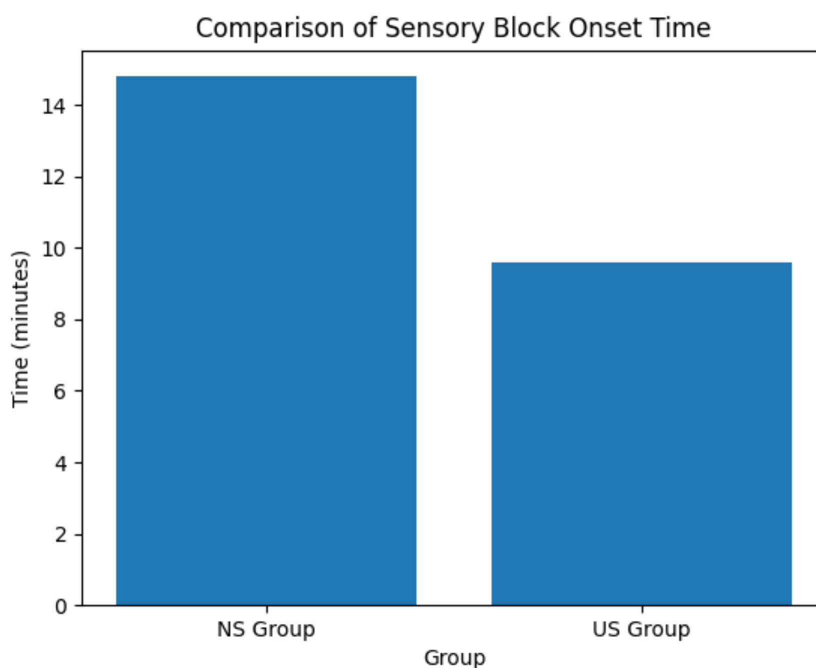

Figure 2: Comparison of sensory onset times between Group NS and Group US

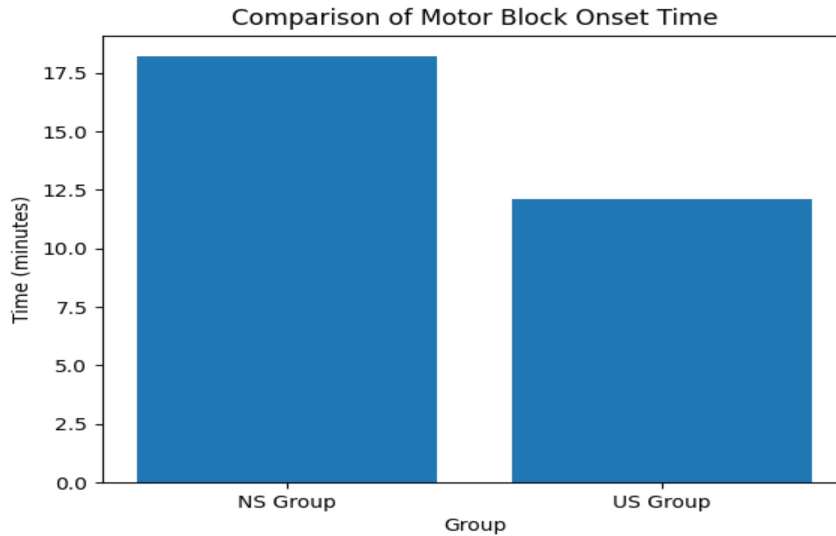

Figure 3: Comparison of motor block onset times between Group NS and Group US

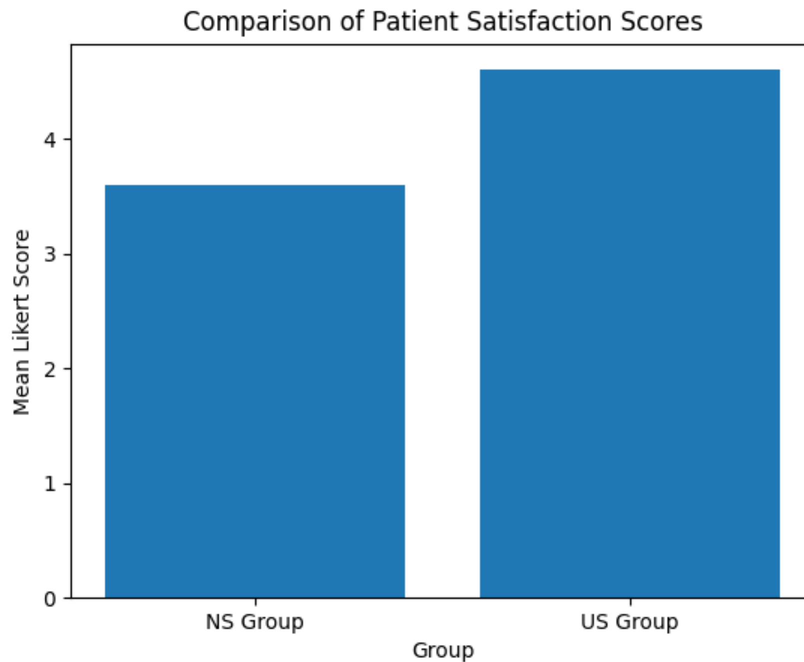

Figure 4: Comparison of patient satisfaction scores between Group NS and Group US

Discussion

The present study demonstrates that ultrasound-guided supraclavicular brachial plexus block provides superior block characteristics compared to nerve stimulator–guided technique. Faster onset of sensory and motor blockade observed in the ultrasound group can be attributed to precise deposition of local anesthetic around the brachial plexus under direct visualization [12,13].

The higher success rate in the ultrasound group is consistent with previous studies reporting improved block reliability due to visualization of neural elements and spread of local anesthetic [14–16]. Reduced complication rates further emphasize the safety advantage of ultrasound guidance, particularly in minimizing vascular puncture and pneumothorax [17].

Prolonged duration of analgesia in the ultrasound group may be explained by optimized local anesthetic distribution and reduced intravascular uptake [18]. Higher patient satisfaction scores reflect reduced discomfort during block placement and effective postoperative analgesia [19].

While nerve stimulator guidance remains a useful technique, especially in settings without ultrasound availability, its limitations are evident. The findings

of this study support growing evidence favoring ultrasound guidance as the preferred modality for supraclavicular brachial plexus block [20–25].

Conclusion

Ultrasound-guided supraclavicular brachial plexus block is associated with faster onset, higher success rate, prolonged analgesia, fewer complications, and improved patient satisfaction compared to nerve stimulator–guided technique. Ultrasound guidance should be encouraged wherever feasible to enhance safety and efficacy in upper limb regional anesthesia.

No conflict of interest among author

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