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Original Research Article

Comparison of Conventional and Ultrasound-Guided Supraclavicular Brachial Plexus Block: A Randomized, Single-Blinded, Prospective Study

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Abstract:

Background: Supraclavicular brachial plexus block is a widely used technique for upper limb surgeries. This study compares the efficacy and safety of the conventional technique versus the ultrasound-guided technique.

Methods: A randomized, single-blinded, prospective study was conducted on 60 patients, aged 18–60 years, classified as ASA I or II, undergoing elective upper limb surgeries. Patients were divided into two groups: Group C (conventional technique) and Group US (ultrasound-guided technique). Demographic data, procedural time, onset and duration of sensory and motor blockades, intraoperative analgesic requirements, block effectiveness, and complications were analyzed. Statistical significance was assessed using appropriate tests, with a p-value < 0.05 considered significant.

Results: Demographic characteristics were comparable between groups. The time to perform the block was shorter in Group C (6.1 ± 2.1 min) than in Group US (9.1 ± 3.2 min) ($p < 0.01$). Onset of sensory (9.1 ± 3.1 min) and motor blockade (9.9 ± 4.9 min) was faster in Group US ($p = 0.002$, $p = 0.02$, respectively). Group US also exhibited longer sensory (6.9 ± 1.1 hrs) and motor block durations (6.9 ± 0.9 hrs) compared to Group C (4.5 ± 2.3 hrs and 6.1 ± 2.1 hrs, respectively) ($p < 0.05$). Intraoperative analgesic requirements and complication rates were significantly lower in Group US ($p < 0.05$). The success rate was higher in Group US (100% vs. 93.1%), with no cases requiring conversion to general anesthesia.

Conclusion: Ultrasound-guided supraclavicular brachial plexus block offers faster onset, prolonged blockade, reduced analgesic requirements, and fewer complications compared to the conventional technique, making it a superior choice for upper limb surgeries.

Keywords: Supraclavicular Block, Ultrasound-Guided Technique, Conventional Technique, Brachial Plexus Block, Upper Limb Surgery.

Introduction

Regional anesthesia techniques, particularly brachial plexus blocks, are widely employed for upper limb surgeries due to their ability to provide excellent intraoperative anesthesia and postoperative analgesia[1,2]. Among these, the supraclavicular brachial plexus block is one of the most effective techniques, offering dense anesthesia and analgesia for the upper extremity[3]. However, the success and safety of this block are highly dependent on precise localization of the brachial plexus[4].

Traditionally, the conventional technique relies on anatomical landmarks and eliciting paresthesia or motor response to identify the brachial plexus[5]. While effective, this technique has limitations, including variable success rates, prolonged procedural times, and a higher risk of complications such as vessel puncture or pneumothorax[4,5].

The advent of ultrasound guidance in regional anesthesia has revolutionized clinical practice, offering real-time visualization of neural structures, surrounding anatomy, and the spread of local anesthetic. This has improved the accuracy, safety, and success rates of regional blocks, including the supraclavicular approach. Ultrasound-guided techniques have demonstrated potential in reducing procedural time, onset time of blockade, and the need for supplemental analgesia while minimizing complications[6].

Despite these advantages, the adoption of ultrasound-guided techniques in resource-constrained settings remains a challenge due to equipment cost, training requirements, and availability. This study aims to compare the conventional and ultrasound-guided techniques of supraclavicular brachial plexus block in terms of procedural efficiency, onset and duration of sensory and motor blockade, intraoperative analgesic requirements, success rates, and complications in patients undergoing upper limb surgeries.

Methodology

Study Design: This randomized, single-blinded, prospective study was conducted after obtaining approval from the Institutional Ethical Committee. A total of 60 patients were included, classified as American Society of Anesthesiologists (ASA) I or II, undergoing elective upper limb surgeries.

Study Setting: The study was conducted at the Konaseema Institute of Medical Sciences and Research Foundation, Amalapuram, between December 2020 and September 2022.

Sample Size: Sixty patients were enrolled and randomly allocated into two groups of 30 each: Group C (conventional technique) and Group US (ultrasound-guided technique).

Inclusion Criteria: Age: 18–60 years

- ASA physical status I or II
- Body mass index (BMI) < 35
- Patients undergoing elbow, forearm, and hand surgeries
- Patients who provided informed written consent

Exclusion Criteria: Patient refusal

- Developmental deformities or dysostosis of the shoulder
- Crush injuries of extremities
- Local site infections or cellulitis
- Compound fractures of the upper limb
- Pre-existing vascular arteriovenous shunts
- Brachial plexus injury
- Bleeding disorders
- Allergy to local anesthetics
- Psychiatric illness

Randomization and Blinding: Patients were randomized into two groups using the "slips in a box" technique. The study was single-blinded, with the patients unaware of the group assignment.

Procedure: Preoperative assessment included recording demographic data, conducting relevant investigations, and stratifying risk based on ASA classification. Patients were premedicated with tablet alprazolam 0.5 mg, tablet ranitidine 150 mg, and tablet metoclopramide 10 mg on the night before surgery.

On the day of surgery, patients were monitored using pulse oximetry, electrocardiography, and non-invasive blood pressure. A supraclavicular brachial plexus block was performed using either the conventional technique (Group C) or ultrasound guidance (Group US) with a mixture of 30 mL of 0.5% bupivacaine and 2% lignocaine with adrenaline.

Evaluation Parameters

Time to perform the block

Onset and duration of sensory and motor block assessed using pinprick and the Modified Bromage scale, respectively

Intraoperative analgesic requirements

Block effectiveness and success rate

Incidence of complications

Statistical Analysis: Data were analyzed using appropriate statistical tests. A p-value < 0.05 was considered significant.

Results

Demographic and Baseline Characteristics: The demographic characteristics of the study participants, including age, gender distribution, and BMI, were comparable between the two groups. There was no statistically significant difference in these parameters, confirming the homogeneity of the groups (Table 1).

Table 1: Demographic Characteristics

Group	Age (mean ± SD)	Male	Female	BMI (mean ± SD)
Group C	34.5 ± 9.8	16	14	23.8 ± 2.9
Group US	33.9 ± 10.1	20	10	23.7 ± 3.1

Procedural Efficiency: The time required to perform the block was significantly shorter in the conventional group (Group C) compared to the ultrasound-guided group (Group US) (6.1 ± 2.1 minutes vs. 9.1 ± 3.2 minutes, p < 0.01) (Table 2).

Sensory and Motor Block Characteristics: The onset of sensory and motor blockade was significantly faster in Group US compared to Group C (sensory block onset: 9.1 ± 3.1 minutes vs. 11.2 ± 4.5 minutes, p = 0.002; motor block onset: 9.9 ± 4.9 minutes vs. 12.6 ± 5.1 minutes, p = 0.02). Additionally, the duration of both sensory and motor blockade was longer in Group US (sensory block: 6.9 ± 1.1 hours vs. 4.5 ± 2.3 hours, p = 0.007; motor block: 6.9 ± 0.9 hours vs. 6.1 ± 2.1 hours, p = 0.01) (Table 3).

Table 2: Procedural Efficiency

Group	Time to Perform Block (mean ± SD, min)	p-value
Group C	6.1 ± 2.1	< 0.01
Group US	9.1 ± 3.2	< 0.01

Table 3: Sensory and Motor Block Characteristics

Parameter	Group C (mean ± SD)	Group US (mean ± SD)	p-value
Onset of Sensory Block (min)	11.2 ± 4.5	9.1 ± 3.1	0.002
Onset of Motor Block (min)	12.6 ± 5.1	9.9 ± 4.9	0.02
Duration of Sensory Block (hrs)	4.5 ± 2.3	6.9 ± 1.1	0.007
Duration of Motor Block (hrs)	6.1 ± 2.1	6.9 ± 0.9	0.01

Intraoperative Analgesic Requirements: Intraoperative analgesic supplementation was required in 10 patients (33.3%) in Group C compared to only 2 patients (6.7%) in Group US, a difference that was statistically significant (p < 0.05) (Table 4).

Table 4: Intraoperative Analgesic Requirements

Group	Required Analgesic Supplementation	p-value
Group C	10	< 0.05
Group US	2	< 0.05

Effectiveness of the Block: The overall effectiveness of the block was higher in Group US, with 27 (90%) totally effective blocks compared to 21 (70%) in Group C. Conversion to general anesthesia was required in one patient in Group C, while no such cases were observed in Group US. These differences were statistically significant (p < 0.05) (Table 5).

Table 5: Effectiveness of the Block

Outcome	Group C (n)	Group US (n)	p-value
Totally Effective	21	27	< 0.05
Partially Effective	8	3	< 0.05
Conversion to GA	1	0	< 0.05

Complications: The incidence of vessel puncture was higher in Group C (5 cases, 16.7%) compared to Group US (2 cases, 6.7%), but this difference was not statistically significant. No other complications, such as drug toxicity, nerve injury, pneumothorax, or phrenic nerve blockade, were observed in either group (Table 6).

Table 6: Complications

Complication	Group C (n)	Group US (n)
Vessel Puncture	5	2
Drug Toxicity	0	0
Nerve Injury	0	0
Pneumothorax	0	0
Phrenic Nerve Blockade	0	0
Horner's Syndrome	0	0
RLN Block	0	0

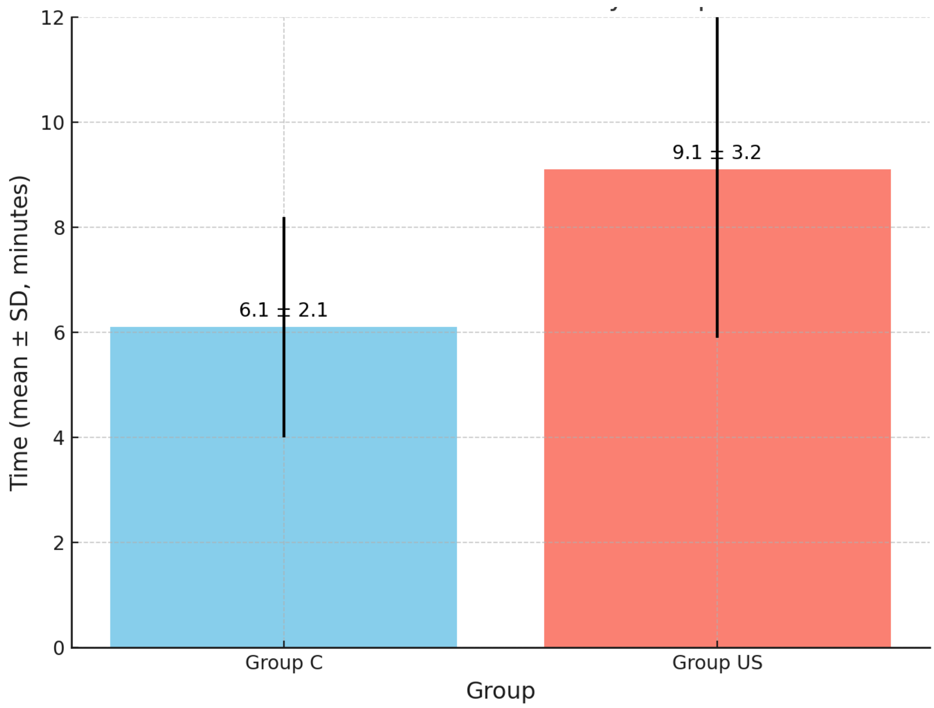

Figure 1: Time to Perform Block by Group

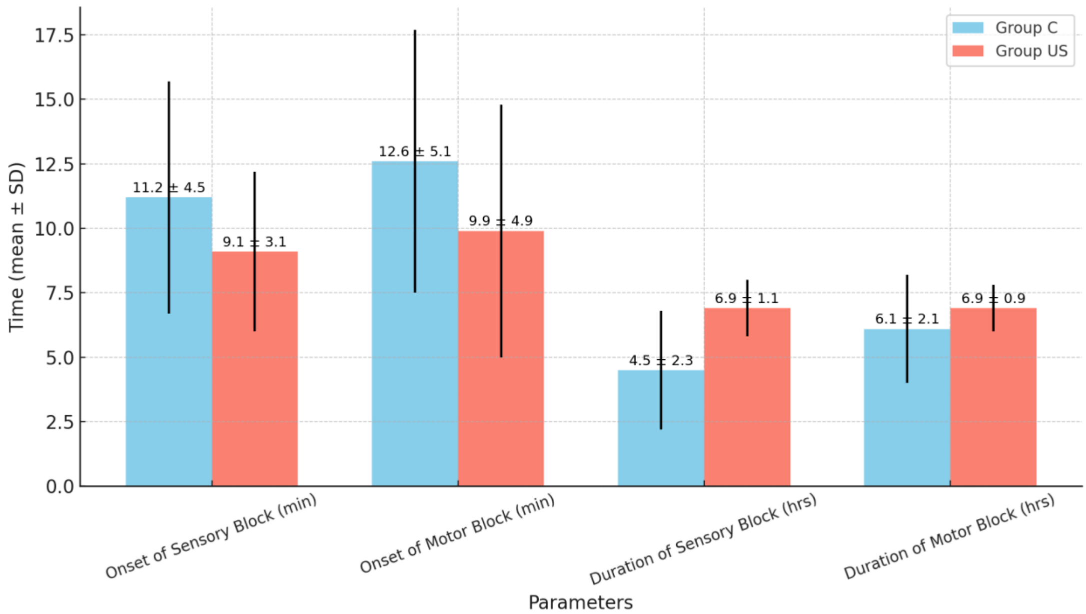

Figure 2: Sensory and Motor Block Characteristics

Discussion

The supraclavicular brachial plexus block is a widely utilized regional anesthesia technique for upper limb surgeries, offering effective anesthesia and postoperative analgesia. This study demonstrated that the ultrasound-guided technique (Group US) provided superior outcomes compared to the conventional technique (Group C) in several aspects.

The faster onset of sensory and motor blockade in Group US (9.1 ± 3.1 min and 9.9 ± 4.9 min, respectively) aligns with findings by Mangal et al., who reported similar results for ultrasound-guided techniques[7]. This is likely due to the precise needle placement and real-time visualization of local anesthetic spread, which enhances block efficiency. Similarly, Tran et al. highlighted the advantage of ultrasound-guided approaches in reducing block onset time compared to conventional methods[8].

The prolonged duration of sensory (6.9 ± 1.1 hrs) and motor blockade (6.9 ± 0.9 hrs) in Group US compared to Group C corroborates the findings of

Guru et al., who reported extended analgesia with ultrasound-guided techniques[9]. This suggests that effective anesthetic deposition achieved through ultrasound guidance contributes to prolonged block efficacy. Luo et al. also emphasized that ultrasound-guided techniques enhance drug distribution around the brachial plexus, leading to improved outcomes[10].

Intraoperative analgesic requirements were significantly lower in Group US (6.7%) compared to Group C (33.3%), consistent with the observations of Duncan et al., who reported reduced supplemental analgesia with ultrasound-guided blocks[11]. Additionally, the success rate of the block was higher in Group US (100%) compared to Group C (93.1%), aligning with findings by Ryu et al. in a similar comparative study[13].

Complications such as vessel puncture were more frequent in Group C (16.7%) but did not reach statistical significance. This finding is consistent with Luo et al., who reported fewer complications with ultrasound-guided techniques due to direct visualization of anatomical structures[12].

Although the conventional technique was faster to perform, this benefit was outweighed by the superior clinical outcomes of the ultrasound-guided approach. However, as highlighted by Tran et al., the adoption of ultrasound-guided techniques may be limited in resource-constrained settings due to cost, equipment availability, and the need for specialized training[8].

Limitations of this study include its single-center design and the small sample size, which may limit the generalizability of the results. Future multicenter studies with larger populations are needed to validate these findings.

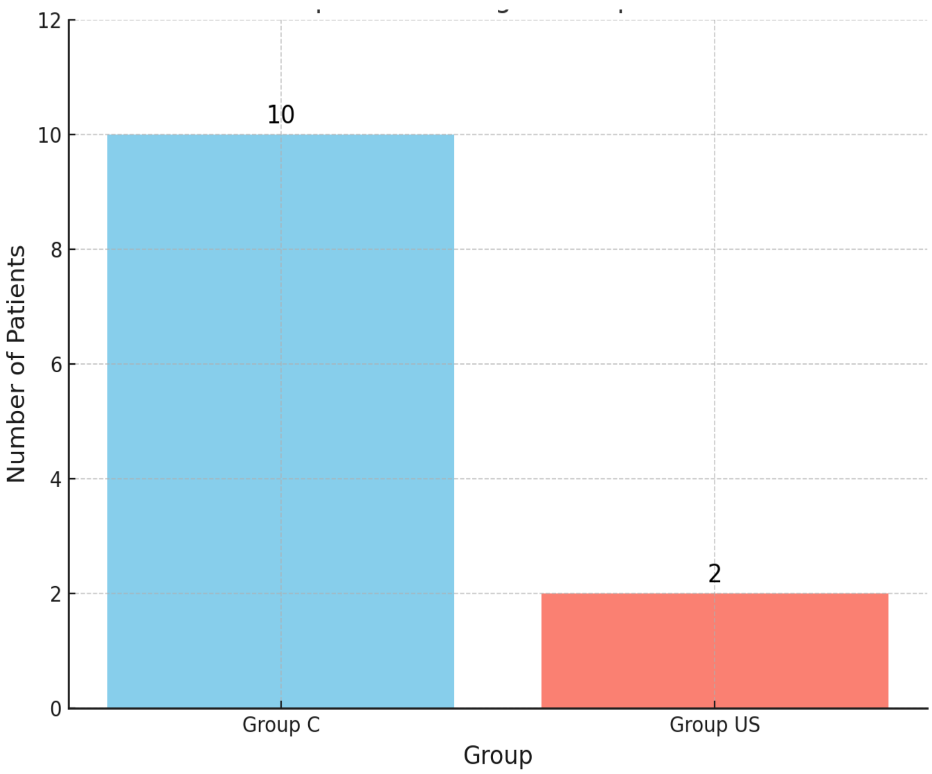

Figure 3: Intraoperative Analgesic Requirements

Conclusion

This study demonstrates that the ultrasound-guided technique for supraclavicular brachial plexus block is superior to the conventional technique. The ultrasound-guided approach provided a faster onset of sensory (9.1 ± 3.1 min) and motor blockade (9.9 ± 4.9 min) and a longer duration of sensory (6.9 ± 1.1 hrs) and motor blockade (6.9 ± 0.9 hrs) compared to the conventional method. It significantly reduced intraoperative analgesic requirements (6.7% vs. 33.3%) and showed a higher success rate (100% vs. 93.1%). While the conventional technique was faster to perform, it had a higher complication rate (vessel puncture: 16.7% vs. 6.7%). These findings highlight the advantages of ultrasound guidance, emphasizing its potential as the preferred technique for upper limb surgeries.

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