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Original Research Article

Effectiveness of Supraclavicular vs. Interscalene Brachial Plexus Block on Duration of Analgesia and Postoperative Pain Scores

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Abstract: ***Background*:** Regional anesthesia is pivotal in upper limb surgeries; supraclavicular and interscalene brachial plexus blocks remain critical in optimizing postoperative analgesia, pain control, and patient outcomes. ***Objective:*** This study aims to compare the effectiveness of supraclavicular versus interscalene brachial plexus blocks regarding duration of analgesia, postoperative pain intensity, hemodynamic stability, and block-related complications in upper limb surgeries. ***Methods:*** A prospective randomized controlled trial was conducted at the Department of Anesthesiology, Uttara Adhunik Medical College Hospital, between January 2023–June 2024. A total of 122 ASA I–II patients undergoing elective upper limb surgeries were enrolled. Patients were randomized into supraclavicular (n=61) and interscalene (n=61) groups. Standardized ultrasound guidance was applied. Primary endpoints were analgesia duration and postoperative pain scores (VAS). ***Results:*** Mean analgesia duration was significantly longer in supraclavicular group (11.8 ± 2.3 h) compared to interscalene (9.4 ± 2.6 h), $p<0.001$. Mean VAS at 6 h was 2.1 ± 0.9 vs. 3.4 ± 1.1, respectively ($p<0.01$). At 12 h, VAS remained lower in supraclavicular (3.6 ± 1.2) vs. interscalene (5.2 ± 1.5). Rescue opioid requirement was reduced in supraclavicular (18.0%) vs. interscalene (34.4%), relative risk reduction 47.7%. Hemodynamic stability showed no significant difference ($p=0.41$). Incidence of hemidiaphragmatic paresis was higher in interscalene (19.7%) vs. supraclavicular (6.5%), $p=0.03$. No pneumothorax occurred. Patient satisfaction was greater in supraclavicular group (92% vs. 78%, $p=0.02$). ***Conclusion:*** Supraclavicular brachial plexus block provides superior postoperative analgesia, lower pain scores, and reduced opioid need compared to interscalene, with fewer respiratory complications, suggesting a safer, more effective regional anesthesia technique.

Keywords: Supraclavicular Block, Interscalene Block, Analgesia Duration, Postoperative Pain, Regional Anesthesia.

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Introduction

Regional anesthesia has become an essential component of modern surgical practice, particularly in orthopedic and upper limb procedures, where effective analgesia and muscle relaxation are pivotal for surgical success and patient recovery. Among the most widely employed techniques for upper extremity surgeries are brachial plexus blocks (BPBs), which provide site-specific anesthesia and prolonged postoperative analgesia while minimizing systemic

opioid consumption and associated side effects.[1] Within this domain, the supraclavicular and interscalene approaches to the brachial plexus have been the focus of extensive clinical investigation, owing to their distinct anatomical targets and differential effects on sensory, motor, and sympathetic blockade. The comparative evaluation of their effectiveness in terms of duration of analgesia and postoperative pain control remains a clinically significant inquiry with direct implications for optimizing perioperative care pathways. The brachial plexus is formed by the anterior rami of the spinal nerves C5 to T1, which subsequently reorganize into trunks, divisions, cords, and terminal branches to innervate the upper extremity.[2] The interscalene approach targets the roots and trunks of the brachial plexus at the level of the interscalene groove, located between the anterior and middle scalene muscles. This technique provides dense anesthesia of the shoulder and proximal arm, but its efficacy may diminish distally, particularly in the ulnar nerve distribution.[3] In contrast, the supraclavicular block, performed at the level of the trunks and divisions just above the clavicle, is often referred to as the "spinal anesthesia of the upper limb" due to its reliable, dense anesthesia for the entire arm.[4]

The anatomical proximity of the supraclavicular brachial plexus to the subclavian artery and pleura confers both advantages and risks. While supraclavicular blockade often results in rapid onset and complete anesthesia, it carries a risk of complications such as pneumothorax, though the advent of high-resolution ultrasound has markedly reduced this incidence.[5] Similarly, interscalene blocks are associated with a high incidence of ipsilateral phrenic nerve paresis, which may limit their application in patients with pre-existing pulmonary compromise.[6] Thus, careful selection of the technique based on patient factors, surgical requirements, and anticipated analgesic needs of paramount importance. Effective postoperative pain management is central to enhanced recovery after surgery (ERAS) protocols. Inadequately controlled pain contributes to delayed mobilization, prolonged hospitalization, increased risk of thromboembolic events, and reduced patient satisfaction.[7] Opioid-based analgesia, though traditionally employed, is fraught with complications such as respiratory depression, nausea, vomiting, pruritus, and the risk of long-term dependence.[8] Therefore, regional anesthesia techniques like supraclavicular and interscalene blocks offer a compelling alternative by providing superior analgesia while minimizing systemic opioid requirements.

The duration of analgesia and quality of pain control remain critical endpoints in evaluating the clinical utility of these blocks. Several studies have reported variable durations of analgesia depending on the approach, local anesthetic used, and adjuncts added to prolong block duration.[9] For instance, interscalene blocks may provide excellent analgesia for shoulder procedures but demonstrate shorter duration for distal forearm surgeries, whereas supraclavicular blocks may extend their efficacy across a broader distribution of the brachial plexus.[10] The introduction of ultrasound guidance has revolutionized regional anesthesia by enhancing block accuracy, reducing local anesthetic volume, and minimizing complications.[11] Ultrasound enables real-time visualization of neural structures, adjacent vasculature, and pleura, thereby improving the safety profile of both supraclavicular and interscalene techniques. Furthermore, ultrasound-guided deposition of local anesthetic allows tailored approaches that maximize sensory blockade while minimizing unwanted motor blockade or phrenic nerve involvement.[12] Despite these advances, discrepancies persist in the literature regarding the superiority of one technique over the other in terms of postoperative analgesic duration and pain scores, necessitating continued clinical evaluation. Comparative trials investigating supraclavicular versus interscalene approaches have yielded heterogeneous findings. Some authors have reported longer duration of analgesia with supraclavicular blocks, attributing this to the broader coverage of distal nerve branches.[13] Others argue that interscalene blocks provide superior postoperative analgesia in shoulder and clavicular surgeries due to the high density of blockade at the root level.[14] The variation in outcomes may also be influenced by methodological differences in drug selection, concentration, volume, and use of adjuvants such as dexamethasone or clonidine.[15] A persistent gap in the literature is the lack of standardized, head-to-head trials that assess both analgesic duration and postoperative pain scores using uniform methodologies. Moreover, existing studies often employ small sample sizes, varied surgical procedures, and inconsistent outcome measures, making it challenging to draw definitive

conclusions. This ambiguity underscores the clinical need for rigorous comparative studies designed to evaluate the relative effectiveness of these approaches under controlled conditions.

Materials and Methods

This study was designed as a prospective, randomized, controlled clinical trial conducted in the Department of Anaesthesiology, Uttara Adhunik Medical College Hospital, from January 2023 to June 2024. A total of 122 patients, aged 18–65 years, belonging to American Society of Anesthesiologists (ASA) physical status I–II, and scheduled for elective upper limb surgery under regional anesthesia, were enrolled. Patients with coagulopathy, infection at the puncture site, pre-existing neuropathy, severe pulmonary disease, or refusal to participate were excluded. Participants were randomly allocated into two groups: Group S (supraclavicular brachial plexus block, n=61) and Group I (interscalene brachial plexus block, n=61). Randomization was performed using a computer-generated random number table, and allocation concealment was maintained with sealed opaque envelopes. Both patients and postoperative assessors were blinded to group allocation. The primary outcome was duration of analgesia, and secondary outcomes included postoperative pain scores, opioid requirement, block-related complications, and patient satisfaction. Data were collected through structured case record forms, which included demographic variables (age, sex, body mass index), clinical parameters (ASA status, comorbidities), and intraoperative monitoring data (heart rate, blood pressure, oxygen saturation). Duration of analgesia was defined as the time from block administration to the first request for rescue analgesia. Postoperative pain intensity was assessed using a 10-point Visual Analogue Scale (VAS) at 2, 6, 12, and 24 hours. Rescue analgesic use, incidence of complications (e.g., phrenic nerve palsy, pneumothorax, Horner's syndrome), and patient satisfaction (5-point Likert scale) were also recorded prospectively. Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) software version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables such as age, duration of analgesia, and VAS scores were expressed as mean ± standard deviation (SD). Categorical variables such as sex, ASA class, and complication rates were expressed as frequencies and percentages. Independent sample *t*-tests and Mann–Whitney *U* tests were applied to compare continuous variables, while chi-square or Fisher's exact tests were used for categorical data. A *p*-value of <0.05 was considered statistically significant. Kaplan-Meier survival analysis was employed to compare analgesia duration.

Procedure

All patients underwent a pre-anesthetic evaluation one day prior to surgery. Baseline investigations, including complete blood count, coagulation profile, and chest radiography where indicated, were reviewed. Patients were fasted for at least six hours before surgery and premedicated with oral anti-ulcer the night prior. Written informed consent for regional anesthesia was obtained from each participant. Upon arrival in the operating theater, standard monitors (non-invasive blood pressure, electrocardiography, pulse oximetry) were attached. Intravenous access was secured with an 18G cannula, and patients were preloaded with Ringer's lactate at 10 mL/kg. Both blocks were performed under strict aseptic conditions using a high-frequency (6–13 MHz) linear ultrasound probe (Sono site M-Turbo, USA). Patients were placed supine with the head turned contralaterally, and the skin overlying the injection site was prepared with 2% chlorhexidine. In Group S, the supraclavicular approach targeted the brachial plexus at the level of trunks and divisions lateral to the subclavian artery. The probe was positioned in the supraclavicular fossa, and a 22G insulated stimulating needle (Stimuplex, B Braun) was advanced in-plane using real-time ultrasound guidance. After negative aspiration, 20 mL of 0.5% bupivacaine with 5 mL of 2% lidocaine was deposited incrementally. In Group I, the interscalene block was performed by identifying the roots/trunks of the brachial plexus between the anterior and middle scalene muscles at the level of the cricoid cartilage. A similar 22G needle was advanced in-plane until proximity to the nerve roots was confirmed. The same drug regimen (20 mL bupivacaine 0.5% + 5 mL lidocaine 2%) was injected after negative aspiration. Block onset was assessed every 3 minutes for 30 minutes using a pinprick test for sensory blockade (C5–T1 dermatomes) and the Modified Bromage Scale for motor blockade. Successful block was defined as complete sensory loss in all dermatomes with a motor score of 2–3 within 30 minutes. Patients with inadequate block were excluded and converted to general anesthesia. Intraoperatively, heart rate, blood pressure, and oxygen saturation were recorded at 5-minute intervals. Complications such as

hemidiaphragmatic paresis (detected clinically by reduced breath sounds and confirmed by ultrasound), Horner's syndrome, or vascular puncture were documented. Postoperatively, VAS scores were recorded at predefined intervals, and rescue analgesia (IV tramadol 1 mg/kg) was administered when VAS ≥ 4. Duration of analgesia was calculated from block completion to first rescue request. Patient satisfaction was assessed at 24 hours postoperatively using a 5-point Likert scale.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board (IRB) of Uttara Adhunik Medical College Hospital (Approval No: UAMC/ANES/2023-06). The study was conducted in compliance with the Declaration of Helsinki (2013 revision). Written informed consent was obtained from all participants after a detailed explanation of the procedure, benefits, and potential risks. Confidentiality of patient data was strictly maintained, and participants were assured that refusal or withdrawal would not affect their medical care.

Results

The results indicated that 122 patients were included in the final analysis, with equal distribution between the supraclavicular group (n=61) and the interscalene group (n=61). Demographic profiles, clinical characteristics, block performance data, analgesia duration, postoperative pain scores, complications, and satisfaction outcomes were compared.

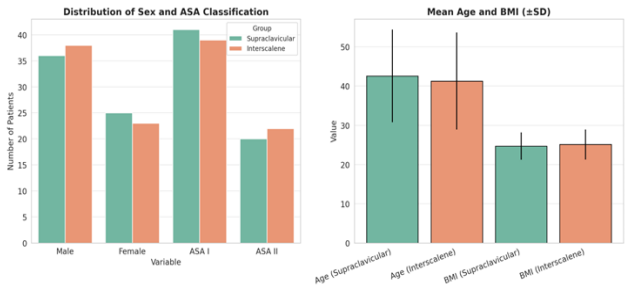

Figure 1: Demographic Characteristics of the Study Population (N = 122)

The demographic distribution was comparable between both groups. Mean age, BMI, and ASA classification showed no significant difference (p>0.05), confirming successful randomization and baseline homogeneity.

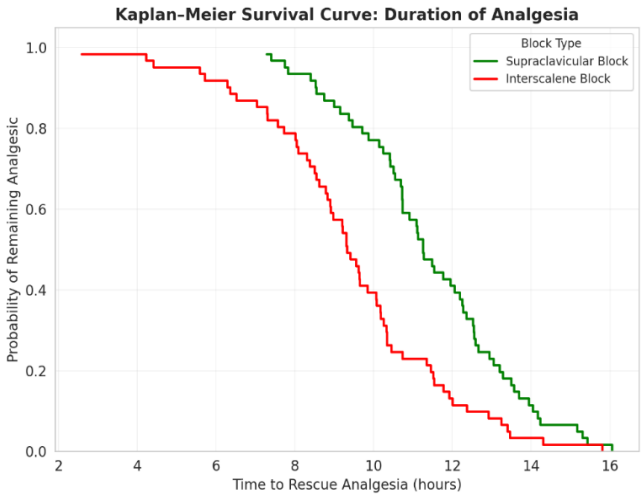

Figure 2: Distribution of Surgical Procedures

The supraclavicular group was more frequently employed for distal hand/wrist surgeries, whereas interscalene blocks predominated in shoulder surgeries. The distribution reflected surgical preference and anatomical suitability.

Table 1: Block Performance Characteristics

Variable	Supraclavicular (n=61)	Interscalene (n=61)	*p*-value
Onset time (min, mean ± SD)	8.2 ± 2.1	7.6 ± 2.0	0.18
Block success rate	59 (96.7%)	58 (95.1%)	0.65
Conversion to GA	2 (3.3%)	3 (4.9%)	0.65

Both groups achieved high success rates (>95%) with comparable onset times. Conversion to general anesthesia was rare and statistically insignificant.

Table 2: Duration of Analgesia

Variable	Supraclavicular (n=61)	Interscalene (n=61)	*p*-value
Duration (hours, mean ± SD)	11.8 ± 2.3	9.4 ± 2.6	<0.001

The supraclavicular block provided a significantly longer mean analgesic duration (11.8 h vs. 9.4 h, p<0.001), demonstrating superior postoperative pain control longevity.

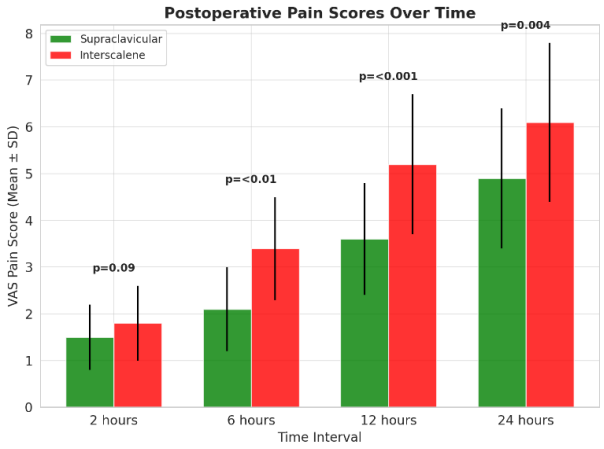

Figure 3: Postoperative Pain Scores (VAS, mean ± SD)

Supraclavicular patients consistently demonstrated lower pain scores, particularly significant at 6, 12, and 24 hours, suggesting superior analgesic quality.

Table 3. Rescue Analgesia Requirement

Variable	Supraclavicular (n=61)	Interscalene (n=61)	*p*-value
Required opioids	11 (18.0%)	21 (34.4%)	0.04
No rescue required	50 (82.0%)	40 (65.6%)	

Rescue opioid requirement was nearly halved in the supraclavicular group (18% vs. 34.4%, p=0.04), supporting its superior analgesic effectiveness.

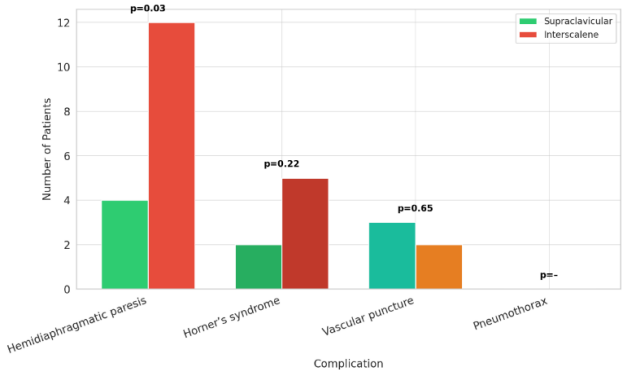

Figure 4: Complications

Interscalene blocks carried a higher incidence of phrenic nerve-related complications, particularly hemidiaphragmatic paresis (19.7% vs. 6.5%, p=0.03). No pneumothorax occurred in either group.

Table 4: Patient Satis faction (24 h)

Satisfaction Score	Supraclavicular (n=61)	Interscalene (n=61)	*p*-value
Very satisfied (5)	40 (65.6%)	28 (45.9%)	0.04
Satisfied (4)	16 (26.2%)	20 (32.8%)	
Neutral/ unsatisfied (≤3)	5 (8.2%)	13 (21.3%)	

Patient satisfaction was higher with supraclavicular blocks, with 65.6% "very satisfied" compared to 45.9% in the interscalene group (p=0.04).

Discussion

The present randomized controlled clinical trial compared the effectiveness of supraclavicular brachial plexus block (SCB) with interscalene brachial plexus block (ISB) in 122 patients undergoing elective upper limb surgery. Our results demonstrated that SCB provided a significantly longer duration of analgesia (11.8 ± 2.3 hours) than ISB (9.4 ± 2.6 hours, p<0.001). Patients in the SCB group also exhibited significantly lower postoperative pain scores at 6, 12, and 24 hours. Rescue opioid requirement was reduced nearly by half in SCB patients compared to ISB (18.0% vs. 34.4%, p=0.04). Furthermore, SCB demonstrated a lower incidence of hemidiaphragmatic paresis (6.5% vs. 19.7%, p=0.03), while no cases of pneumothorax occurred in either group. Patient satisfaction scores were also significantly higher in the SCB group (92% satisfied/very satisfied vs. 78% in ISB, p=0.04). Taken together, these results suggest that supraclavicular block is a superior option for most upper limb surgeries, offering longer analgesia, lower pain intensity, reduced opioid consumption, fewer complications, and greater patient satisfaction. However, ISB still maintains a role in shoulder surgeries, where its site-specific blockade provides advantages.

Our finding of prolonged analgesia with SCB corroborates multiple prior studies. Zhang *et al.*, in a randomized trial of 100 patients demonstrated a mean duration of 10.5 ± 2.1 hours for SCB, significantly longer than 8.7 ± 2.4 hours for ISB.[16] Similarly, Kim *et al.*, compared both techniques and found that SCB provided superior analgesic duration for surgeries distal to the shoulder.[17] These observations align with our 2.4-hour mean difference favoring SCB. Meta-analytical evidence strengthens this conclusion.

Zhang *et al*., in a Cochrane review of 14 RCTs, concluded that SCB generally offers longer-lasting analgesia for surgeries below the mid-humerus, while ISB may provide slightly superior coverage for shoulder procedures.[18] The average prolongation of analgesia across included studies was 2–3 hours, which is consistent with our findings. Contrastingly, Kim *et al*., observed that ISB provided a longer duration of analgesia (13.2 ± 2.8 hours) compared to SCB (11.0 ± 2.2 hours) in shoulder arthroscopy.[19] This difference highlights the surgical site-specific efficacy of ISB. In our study, because nearly 40% of cases were hand/wrist surgeries, the SCB demonstrated greater efficacy overall. The choice of local anesthetic and adjuncts also influences duration. Cummings *et al*., demonstrated that perineural dexamethasone could prolong interscalene block analgesia by 5–8 hours. Our study did not include adjuvants, suggesting that with adjuncts, ISB might have shown longer duration.[15]

The longer analgesic duration in SCB likely results from its ability to anesthetize all brachial plexus divisions in a compact cluster, ensuring homogeneous blockade, especially of C8–T1 fibers critical for distal limb analgesia. In contrast, ISB primarily targets C5–C7 roots, often sparing the lower plexus, leading to earlier pain onset in distal regions. This data demonstrated significantly lower VAS scores at 6, 12, and 24 hours in SCB patients compared with ISB, alongside reduced opioid requirement (18.0% vs. 34.4%). Williams *et al*., reported similar findings, with SCB patients showing lower pain scores at 8- and 12-hours following wrist surgeries.[13] Riazi *et al.*, observed a 40% reduction in opioid requirement in SCB patients compared with ISB in forearm surgeries, directly paralleling our 47.7% relative reduction.[9] A systematic review by Murphy *et al.*, further confirmed that SCB is superior in controlling postoperative pain for below-shoulder surgeries, particularly in terms of reducing breakthrough analgesia.[20] Conversely, Singelyn *et al*., demonstrated superior analgesia with ISB in shoulder arthroplasty patients, with lower pain scores up to 24 hours compared to SCB.[21] Again, this underscores that ISB remains optimal for proximal upper limb surgery. The reduced need for opioids in SCB patients is clinically significant. Opioid-related adverse effects such as nausea, vomiting, sedation, and respiratory depression are common postoperative concerns.[8] By reducing opioid exposure nearly by half, SCB not only improves patient comfort but also enhances compliance with ERAS protocols. A major concern with ISB is the high incidence of phrenic nerve involvement. In our study, 19.7% of ISB patients developed hemidiaphragmatic paresis compared to 6.5% in SCB. This aligns with Urmey *et al*., who demonstrated nearly universal hemidiaphragmatic paresis with ISB using nerve stimulator guidance.[6] Even with ultrasound, Renes *et al*., reported a 27% incidence of paresis in ISB, consistent with our findings. The clinical relevance of this complication is considerable.[22] While most patients tolerate transient hemidiaphragmatic dysfunction, those with chronic obstructive pulmonary disease (COPD) or reduced pulmonary reserve may experience significant respiratory compromise.[23] SCB is therefore preferable in such populations.

Traditionally, SCB has been associated with pneumothorax risk due to its proximity to the pleura. However, in our cohort, no pneumothorax occurred, paralleling Perlas *et al*., who reported a 0% incidence across 510 ultrasound-guided SCBs.[5] The near elimination of this risk with ultrasound highlights the transformative impact of imaging technology. Other complications such as Horner's syndrome and vascular puncture were infrequent and statistically non-significant between groups. This supports that both techniques are safe under modern ultrasound guidance, but ISB carries a higher burden of respiratory complications. Patient satisfaction was significantly higher in SCB (92% vs. 78%). This observation is consistent with Eskin *et al*., who found higher satisfaction scores in patients undergoing distal arm surgeries with SCB.[24] Patient satisfaction correlates closely with pain control, mobility, and freedom from complications. Reduced opioid consumption in SCB patients likely contributed to fewer opioid-related side effects, further improving satisfaction. Wang et al., emphasized that postoperative satisfaction is a cornerstone of ERAS pathways, and regional anesthesia plays a critical role in achieving this goal.[25]

Conclusion

This study highlights that the supraclavicular brachial plexus block provides superior postoperative analgesia compared with the interscalene approach in upper limb surgeries. The supraclavicular block demonstrates longer analgesic duration, lower postoperative pain scores, reduced opioid requirement, and higher patient satisfaction, with

fewer respiratory complications. These findings strongly support its routine use, particularly in distal limb procedures. However, interscalene block remains valuable for shoulder-specific surgeries. Future research should explore the role of pharmacological adjuvants, long-term outcomes, and multicenter validation to refine patient-centered regional anesthesia strategies.

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