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Original Research Article

Duration of Analgesia after Ultrasound-Guided Brachial Plexus Block with Perioperative Intravenous Dexamethasone for Upper Limb Surgery: A Prospective Observational Study

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ABSTRACT
Background: Brachial plexus blocks are widely used for perioperative anaesthesia and postoperative analgesia in upper limb surgery. Interscalene, supraclavicular and axillary approaches are selected according to the anatomical site of surgery, while adjuvants such as dexamethasone are commonly used to prolong analgesic duration and reduce rescue analgesic requirement.
Objective: To evaluate block characteristics, duration of analgesia, postoperative pain scores, 24-hour opioid requirement, patient satisfaction and early adverse events among patients receiving ultrasound-guided interscalene, supraclavicular or axillary brachial plexus blocks with perioperative intravenous dexamethasone.
Materials and Methods: This prospective observational study included 60 patients undergoing upper limb surgery. Twenty patients each received interscalene, supraclavicular or axillary brachial plexus block according to surgical site. Study period: 2023-2025. All patients received 0.5% bupivacaine, with local anaesthetic volume determined by block approach. Dexamethasone 8 mg was administered intravenously immediately after block placement. Postoperative analgesia included intravenous paracetamol 1 g every 8 hours, with intravenous tramadol 50 mg as rescue analgesia when the numerical rating scale pain score was ≥4. Recorded outcomes included block performance time, sensory and motor onset, duration of analgesia, pain at rest at 6, 12, 24 and 48 hours, 24-hour opioid consumption in morphine-equivalent dose, satisfaction score, block success and adverse events.
Results: The mean age was 47.20±16.88 years, and 30 patients were male. Each block group included 20 patients, with equal male and female representation. Mean duration of analgesia was 20.54±3.87 hours in the interscalene group, 20.01±4.42 hours in the supraclavicular group and 20.59±4.72 hours in the axillary group (p=0.899). Pain scores remained low during the first 48 postoperative hours. Median 24-hour opioid requirement was 3 mg morphine equivalent in all three groups. Block success was achieved in all 60 patients. Hoarseness was significantly more frequent after interscalene block (p=0.046), while Horner syndrome showed a higher but statistically non-significant frequency in the interscalene group.
Conclusion: Ultrasound-guided brachial plexus blocks with perioperative intravenous dexamethasone provided effective postoperative analgesia for upper limb surgeries, with approximately 20 hours of analgesic duration, low early pain scores, limited opioid requirement and high patient satisfaction. The analgesic profile was broadly comparable across the three approaches, although hoarseness and Horner syndrome were observed more often after interscalene block.

Keywords: Brachial Plexus Block, Interscalene Block, Supraclavicular Block, Axillary Block, Bupivacaine, Dexamethasone, Postoperative Analgesia, Upper Limb Surgery.

INTRODUCTION

Postoperative pain after upper limb surgery is not a minor recovery complaint. It affects sleep, early mobilisation, physiotherapy participation, discharge readiness and the patient's confidence in subsequent treatment. Contemporary perioperative pain guidance therefore supports procedure-specific, multimodal analgesia, with regional anaesthesia used wherever anatomical access and clinical expertise permit.[1,2]

Brachial plexus blockade is one of the most established regional anaesthetic strategies for upper limb surgery. The interscalene approach is commonly selected for shoulder and proximal humeral procedures, the supraclavicular approach provides dense anaesthesia for surgeries around the arm and elbow, and the axillary approach is useful for distal forearm, wrist and hand procedures.[3] This anatomical tailoring is clinically important in Indian tertiary-care hospitals, where high surgical turnover and limited monitored recovery resources make durable single-shot analgesia particularly valuable.

Ultrasound guidance has changed the safety and precision of peripheral nerve blockade. Direct visualisation of the brachial plexus, adjacent vessels, pleura, needle trajectory and local anaesthetic spread allows more controlled injection and may reduce the need for supplementation or conversion to general anaesthesia. Evidence from systematic reviews supports improved block adequacy with ultrasound guidance compared with peripheral nerve stimulation, landmark-based or transarterial techniques.[4]

The duration of analgesia after a single-shot brachial plexus block depends on the local anaesthetic used, volume, block approach, surgical site, patient factors and adjuvant administration. Bupivacaine remains widely used in Indian anaesthesia practice because of its long duration of action and ready availability. Dexamethasone has also been evaluated extensively as an adjunct to peripheral nerve blockade. Both perineural and intravenous routes have been studied, with several trials and meta-analyses showing prolongation of analgesia after brachial plexus block.[5-8] Intravenous dexamethasone is especially attractive in routine settings because it avoids uncertainty about off-label perineural steroid exposure while preserving a practical analgesic benefit.

Even so, clinical documentation across different brachial plexus approaches remains useful. Direct comparison requires caution because the block approach usually follows surgical site rather than random allocation. A shoulder procedure, elbow fixation and hand surgery do not carry identical pain burdens. Still, recording analgesic duration, pain scores, rescue analgesic requirement and adverse events across routine block approaches can help departments refine perioperative analgesia protocols.

The present study evaluated the postoperative analgesic profile and safety outcomes of ultrasound-guided interscalene, supraclavicular and axillary brachial plexus blocks performed with 0.5% bupivacaine and perioperative intravenous dexamethasone in patients undergoing upper limb surgery.

MATERIALS AND METHODS

Study Design and Setting

This was a hospital-based prospective observational study conducted among patients undergoing upper limb surgery managed with ultrasound-guided brachial plexus block.

Study Period

2023-2025.

Study Population

The study included 60 patients undergoing shoulder, arm, elbow, forearm, wrist or hand procedures. Patients received one of three brachial plexus approaches according to surgical site: interscalene block, supraclavicular block or axillary block. Each group included 20 patients.

Inclusion Criteria

Patients undergoing upper limb surgery under brachial plexus block, belonging to ASA physical status I-III, and for whom postoperative pain scores and analgesic consumption were recorded were included.

Exclusion Criteria

Patients with contraindications to peripheral nerve block, known allergy to local anaesthetic agents, coagulopathy, infection at the injection site, pre-existing major neurological deficit in the operative limb, or incomplete perioperative analgesic records were excluded.

Block Technique and Drug Regimen

All blocks were performed under ultrasound guidance using standard aseptic precautions. The block approach was selected according to surgical site. Patients received 0.5% bupivacaine. The recorded local anaesthetic volume was 15-20 mL for interscalene block, 20-30 mL for supraclavicular block and 25-35 mL for axillary block. Dexamethasone 8 mg was administered intravenously immediately after block placement in all patients.

Postoperative Analgesic Protocol

Postoperative analgesia included intravenous paracetamol 1 g every 8 hours. Rescue analgesia consisted of intravenous tramadol 50 mg administered when the numerical rating scale pain score was ≥4, with repeat dosing according to clinical requirement and institutional safety limits. Total 24-hour tramadol consumption was converted to morphine-equivalent dose for analysis using the conversion ratio of 100 mg tramadol as approximately equivalent to 10 mg oral morphine.

Outcome Measures

The primary outcome was duration of analgesia in hours, defined as the time from completion of block placement to first requirement of rescue analgesia or clinically meaningful return of pain. Secondary outcomes included block performance time, sensory onset time, motor onset time, pain at rest at 6, 12, 24 and 48 hours, total 24-hour opioid consumption in morphine-equivalent milligrams, patient satisfaction score on a 0-10 scale, block success, nausea, vomiting, hoarseness and Horner syndrome.

Statistical Analysis

Continuous variables were summarised as mean±standard deviation or median with range, depending on distribution and clinical relevance. Categorical variables were expressed as frequency and percentage. Intergroup comparisons for normally distributed continuous variables were performed using one-way analysis of variance. Ordinal or non-normally distributed variables were compared using the Kruskal-Wallis test. Categorical variables were compared using chi-square test. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 60 patients were included, with 20 patients each in the interscalene, supraclavicular and axillary block groups. The mean age of the cohort was 47.20±16.88 years, with a range of 18-78 years. There were 30 males and 30 females. Each block group had equal male and female representation. ASA II was the most common physical status category (Table 1). The equal distribution of the three block approaches is shown in Figure 1.

Block type	Age (years), mean±SD	Sex, M/F	BMI (kg/m²), mean±SD	ASA I/II/III, n
Interscalene	47.45±16.37	10/10	27.17±3.84	5/11/4
Supraclavicular	47.55±16.77	10/10	27.01±4.17	4/11/5
Axillary	46.60±18.31	10/10	26.46±4.23	3/13/4

Table 1. Baseline Demographic and ASA Profile

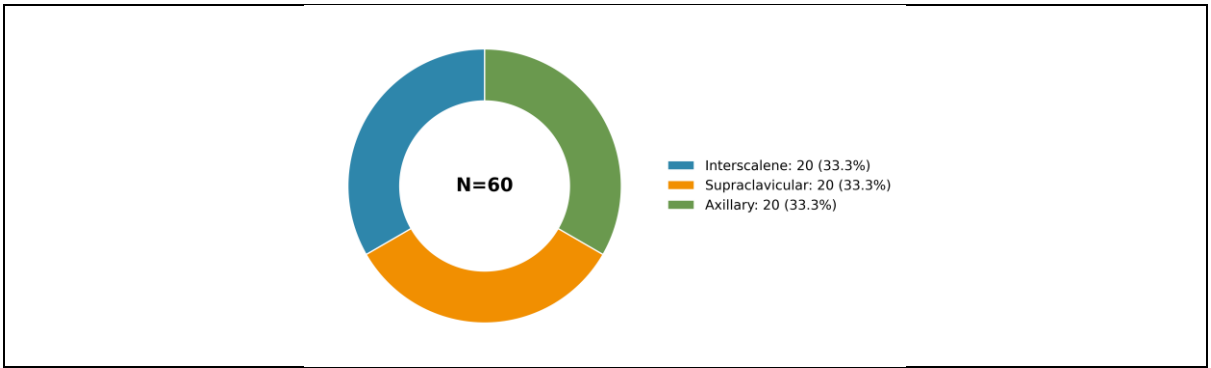

Figure 1. Distribution of Brachial Plexus Block Approaches

Donut chart shows equal distribution of interscalene, supraclavicular and axillary blocks, with 20 patients in each group

The local anaesthetic volume differed significantly between the three approaches, reflecting anatomical differences in block technique. Block performance time was comparable across all groups, with the same mean value recorded for interscalene, supraclavicular and axillary blocks. Sensory and motor onset times were similar. The mean duration of analgesia was approximately 20 hours in all three groups, with no statistically significant intergroup difference (Table 2 and Figure 2).

Parameter	Interscalene	Supraclavicular	Axillary	p-value
Local anaesthetic volume (mL), mean±SD	17.40±2.06	25.20±3.66	30.00±3.49	<0.001
Block performance time (min), mean±SD	6.30±1.59	6.30±1.59	6.30±1.59	1.000
Sensory onset (min), mean±SD	14.80±3.27	14.80±3.33	15.20±3.69	0.914
Motor onset (min), mean±SD	19.80±3.27	19.80±3.33	20.20±3.69	0.914
Duration of analgesia (h), mean±SD	20.54±3.87	20.01±4.42	20.59±4.72	0.899

Table 2. Block Characteristics and Duration of Analgesia

SD: standard deviation

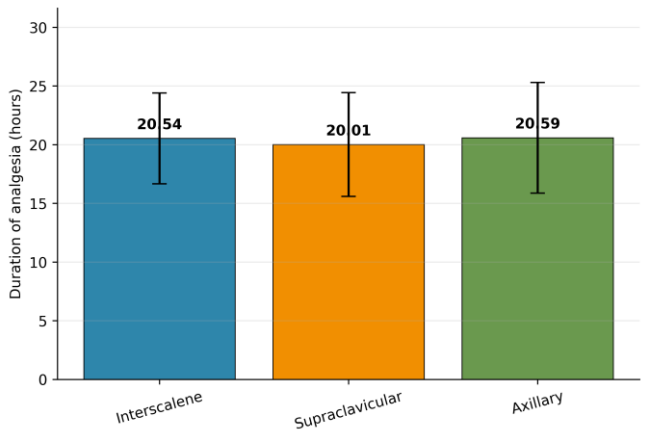

Figure 2. Mean Duration of Analgesia Across Block Approaches

Bar chart shows mean analgesic duration in hours. Error bars represent standard deviation

Pain scores at rest remained zero at 6 hours in all groups. At 12 hours, pain was negligible, with only occasional non-zero values. Pain increased modestly at 24 hours and declined again by 48 hours. The median 24-hour opioid consumption was 3 mg morphine equivalent in each group. Patient satisfaction was high across all three block approaches (Table 3 and Figure 3).

Outcome	Interscalene	Supraclavicular	Axillary	p-value
Pain at rest 6 h, median (range)	0 (0-0)	0 (0-0)	0 (0-0)	-
Pain at rest 12 h, median (range)	0 (0-0)	0 (0-1)	0 (0-2)	0.601
Pain at rest 24 h, median (range)	1.5 (0-6)	2 (0-6)	1.5 (0-6)	0.990
Pain at rest 48 h, median (range)	1 (0-3)	1 (0-3)	1 (0-3)	0.829
Total opioid consumption 24 h, ME mg, median (range)	3 (0-8)	3 (0-9)	3 (0-9)	0.966
Satisfaction score, median (range)	9 (7-10)	9.5 (7-10)	9.5 (7-10)	0.940

Table 3. Postoperative Pain, Opioid Consumption and Satisfaction

ME mg: morphine-equivalent milligrams

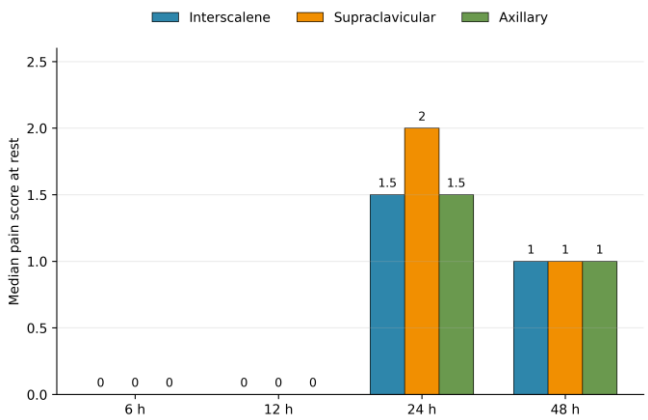

Figure 3. Postoperative Pain Scores at Rest over 48 Hours

Clustered bar chart shows median pain scores at 6, 12, 24 and 48 hours across the three block groups

Block success was achieved in all 60 patients. Nausea occurred in 5 patients overall, vomiting in 1 patient, hoarseness in 7 patients and Horner syndrome in 5 patients. Hoarseness differed significantly between groups and was most frequent after interscalene block. Horner syndrome was also more frequent after interscalene block, although the difference did not reach statistical significance (Table 4 and Figure 4).

Event	Interscalene, n (%)	Supraclavicular, n (%)	Axillary, n (%)	p-value
Block success	20 (100.0)	20 (100.0)	20 (100.0)	-
Nausea	2 (10.0)	2 (10.0)	1 (5.0)	0.804
Vomiting	0 (0.0)	1 (5.0)	0 (0.0)	0.362
Hoarseness	5 (25.0)	2 (10.0)	0 (0.0)	0.046
Horner syndrome	4 (20.0)	1 (5.0)	0 (0.0)	0.059

Table 4. Block Success and Adverse Events

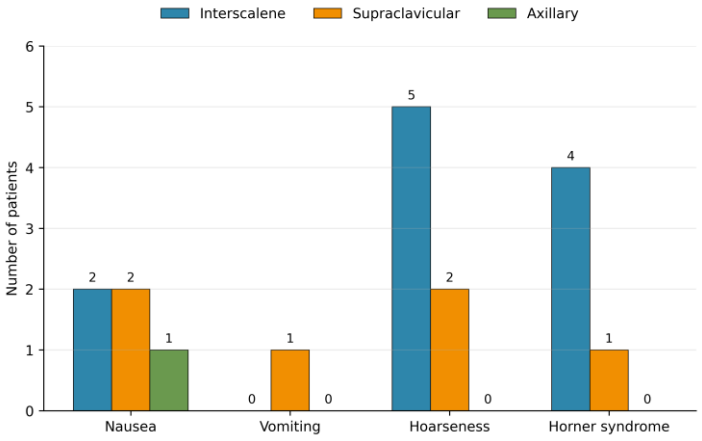

Figure 4. Adverse Events by Block Approach

Clustered bar chart shows nausea, vomiting, hoarseness and Horner syndrome across interscalene, supraclavicular and axillary block groups

DISCUSSION

The present study showed that ultrasound-guided interscalene, supraclavicular and axillary brachial plexus blocks performed with 0.5% bupivacaine and perioperative intravenous dexamethasone produced a consistent postoperative analgesic profile in upper limb surgeries. The duration of analgesia was close to 20 hours across all three approaches, pain scores remained low during the first 48 postoperative hours, rescue opioid requirement was limited, and patient satisfaction was high. The approximately 20-hour analgesic duration observed here is clinically meaningful. Single-

shot brachial plexus blocks are often expected to cover the most painful early postoperative window, but their usefulness depends on whether they can reduce pain through the first night after surgery. In this cohort, most patients required little rescue opioid during the first 24 hours, suggesting that the block-dexamethasone combination provided effective opioid-sparing analgesia.

These findings are consistent with the pharmacological rationale for dexamethasone use in peripheral nerve blockade. Systematic reviews have reported prolongation of analgesia when dexamethasone is used with local anaesthetic agents in brachial plexus block.[5,6] Abdallah et al. demonstrated that intravenous dexamethasone prolonged analgesia after supraclavicular brachial plexus block, and subsequent meta-analyses have continued to evaluate whether perineural administration offers meaningful advantage over systemic administration.[7-9] From a practical viewpoint, the intravenous route is attractive because it avoids uncertainty about off-label perineural steroid exposure while remaining simple to implement in routine perioperative care.

The similarity in sensory and motor onset times across the three groups is also relevant. Mean sensory onset was approximately 15 minutes and mean motor onset approximately 20 minutes. This onset profile is acceptable for planned upper limb procedures because it allows adequate time for block assessment without substantially delaying operating-room flow. The comparable block performance time across all three approaches suggests that, within this clinical workflow, ultrasound-guided interscalene, supraclavicular and axillary blocks could be performed within a similar procedural time window.

The difference in local anaesthetic volume between groups was expected and should not be misread as a comparative efficacy signal. Interscalene block targets a relatively compact neural structure at the root/trunk level, whereas axillary block often requires spread around multiple terminal branches. The significantly higher volume in the axillary group therefore reflects anatomical and technical requirements rather than greater analgesic need.

The adverse event pattern was anatomically plausible. Hoarseness and Horner syndrome occurred most often after interscalene block. This is consistent with the proximity of the interscalene injection site to cervical sympathetic pathways and laryngeal or phrenic-related spread. Riazi et al. showed that local anaesthetic volume influences respiratory consequences after interscalene block, reinforcing the importance of volume-conscious technique in proximal brachial plexus blockade.[10] Kim et al. also compared interscalene and supraclavicular approaches for shoulder surgery, reflecting the wider clinical search for analgesic strategies that preserve efficacy while reducing neck-related or diaphragmatic side effects.[11]

Alternative regional strategies have also been explored to reduce interscalene-related neck or diaphragmatic effects while preserving shoulder analgesia, including combined suprascapular-axillary nerve blocks and more distal brachial plexus approaches.[12,13] Indian studies evaluating dexamethasone as an adjunct in supraclavicular brachial plexus block have similarly reported prolongation of analgesia and improved block characteristics, supporting the practical relevance of dexamethasone-assisted regional analgesia in local perioperative practice.[14,15]

In the Indian perioperative setting, these findings have practical relevance. Many upper limb procedures are performed in high-throughput teaching hospitals where early ambulation, discharge planning and nursing workload are important realities. A reliable block providing nearly one day of analgesia can reduce repeated rescue analgesic requests and may improve patient experience, especially after evening surgeries. The opioid-sparing effect is also valuable because nausea, sedation and delayed mobilisation can complicate recovery, and opioid availability may vary between institutions.

However, this study should be interpreted with appropriate caution. The block approach was selected according to surgical site rather than random allocation. Therefore, the three groups are not truly procedure-equivalent. Shoulder, elbow and hand surgeries differ in tissue trauma and postoperative pain trajectory. The study is best understood as a prospective clinical profile of site-appropriate brachial plexus block practice rather than a randomised comparison proving equivalence between approaches.

Limitations

This study had a modest sample size, with 20 patients in each block group. The block

approach was determined by surgical site, so intergroup comparisons are descriptive rather than causally comparative. Surgical procedures were heterogeneous within each anatomical region. The study recorded early postoperative outcomes up to 48 hours, so delayed neurological symptoms, rebound pain after discharge and longer-term functional outcomes were not assessed. Diaphragmatic movement was not evaluated, limiting detailed interpretation of interscalene-related respiratory effects.

CONCLUSION

Ultrasound-guided brachial plexus blocks using 0.5% bupivacaine with perioperative intravenous dexamethasone provided effective postoperative analgesia for upper limb surgeries. Analgesic duration was approximately 20 hours across interscalene, supraclavicular and axillary approaches, with low postoperative pain scores, limited 24-hour opioid requirement and high patient satisfaction. Hoarseness and Horner syndrome were observed more frequently after interscalene block, highlighting the need for approach-specific monitoring. Overall, site-appropriate brachial plexus blockade remains a practical opioid-sparing strategy for upper limb surgical analgesia.

Source of Funding

Nil.

Conflict of Interest

None declared.

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