Biological and Clinical Sciences Research Journal
eISSN: 2708-2261; pISSN: 2958-4728
www.bcsrj.com
DOI: https://doi.org/10.54112/bcsrj.v6i5.2217
*Biol. Clin. Sci. Res. J., Volume 6(5), **2025**: 2217*
Original Research Article

A Comparative Study on Duration of Supraclavicular Plexus Block Using Dexamethasone vs Tramadol as an Adjuvant to Bupivacaine for Arm and Forearm Surgeries

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(Received, 14th April 2025, Accepted 28th May 2025, Published 31st May 2025)

Abstract: *Supraclavicular brachial plexus block is widely used for upper limb surgeries due to its rapid onset and reliable anesthesia. However, the limited duration of analgesia with local anesthetics necessitates the use of adjuvants. Dexamethasone and tramadol are commonly used agents, but comparative evidence in the Pakistani population remains limited.* ***Objective:*** *To compare the effects of dexamethasone versus tramadol as adjuvants to bupivacaine on the duration of supraclavicular brachial plexus block in patients undergoing arm and forearm surgeries.* ***Methods:*** *This comparative study was conducted at the Department of Anesthesia, Aziz Bhatti Shaheed Teaching Hospital, Gujrat, from April 2024 to March 2025. A total of 70 patients (ASA I–II), aged 18–60 years, were assigned to two groups. Group A received bupivacaine with dexamethasone (8 mg), while Group B received bupivacaine with tramadol (100 mg). Primary outcomes included onset and duration of sensory and motor block, and duration of analgesia. Secondary outcomes included pain scores (VAS), rescue analgesic requirement, and adverse effects. Data were analyzed using SPSS version 26, with $p \leq 0.05$ considered statistically significant.* ***Results:*** *The mean age of participants was 38.9 ± 11.6 years, with a predominance of males. Baseline characteristics were comparable between groups. Dexamethasone demonstrated significantly faster onset of sensory (11.2 ± 2.4 vs 13.1 ± 2.8 minutes, p=0.003) and motor block (15.6 ± 3.1 vs 17.9 ± 3.5 minutes, p=0.005). It also significantly prolonged sensory block (812.4 ± 108.6 vs 641.8 ± 96.3 minutes), motor block (694.2 ± 101.7 vs 548.9 ± 88.4 minutes), and duration of analgesia (928.6 ± 121.4 vs 716.5 ± 104.9 minutes) (p<0.001 for all). Pain scores were significantly lower in the dexamethasone group at 6, 12, and 24 hours. Fewer patients required early rescue analgesia (22.9% vs 60.0%, p=0.002), and total analgesic consumption was reduced. Hemodynamic parameters were comparable, while nausea and vomiting were more frequent in the tramadol group.* ***Conclusion:*** *Dexamethasone is superior to tramadol as an adjuvant to bupivacaine in supraclavicular brachial plexus block, providing faster onset, prolonged analgesia, improved pain control, and fewer adverse effects.*

Keywords: Brachial plexus block, dexamethasone, tramadol, bupivacaine, supraclavicular block, postoperative analgesia

[***How to Cite:*** Sultan N, Javed HM, Mir AJ, Adnan H, Ahmed D. A comparative study on duration of supraclavicular plexus block using dexamethasone vs tramadol as an adjuvant to bupivacaine for arm and forearm surgeries. *Biol. Clin. Sci. Res. J.*, **2025;** 6(5): 400-403. doi: https://doi.org/10.54112/bcsrj.v6i5.2217

Introduction

Brachial plexus block is a widely used regional anesthetic technique that provides an effective and cost-efficient alternative to general anesthesia for upper limb surgeries (1–3). It involves the administration of local anesthetic agents near the brachial plexus, resulting in reversible loss of sensation and motor function in the upper extremity (3). The brachial plexus, formed by the anterior rami of C5–T1 nerve roots, innervates most dermatomes and osteotomes of the upper limb, making it suitable for surgeries involving the arm, forearm, and hand (4,5). Among the various approaches—including interscalene, supraclavicular, infraclavicular, and axillary—the supraclavicular approach is considered highly reliable due to the compact arrangement of nerve trunks at this level, allowing rapid onset and dense blockade (2,6–8).

Bupivacaine, a long-acting amide local anesthetic, is commonly used because of its prolonged duration and favorable sensory-to-motor block profile (1,9,10). However, the analgesic duration of local anesthetics alone is often limited to 4–8 hours, which may be inadequate for postoperative pain control (2,5). To overcome this limitation, various adjuvants—including opioids, α2-agonists, and corticosteroids—have been investigated to enhance block quality and prolong analgesia (1,11,12).

Dexamethasone, a long-acting corticosteroid, has gained attention due to its anti-inflammatory and analgesic effects (2,6,13). It is believed to prolong nerve blockade by inhibiting nociceptive transmission, inducing vasoconstriction, and reducing the release of inflammatory mediators (8,13). Evidence suggests that dexamethasone significantly prolongs analgesia compared to placebo and other adjuvants (11). Tramadol, a weak μ-opioid receptor agonist with additional monoaminergic activity, has also been used as an adjuvant, although its effect appears comparatively modest (4,11). Previous studies have shown that dexamethasone provides superior block characteristics compared to tramadol (1,3).

In Pakistan, upper limb injuries from road traffic accidents, occupational hazards, and domestic trauma contribute significantly to orthopedic surgical workloads, especially in tertiary care hospitals. The supraclavicular brachial plexus block is commonly used because of its simplicity and safety compared with general anesthesia. However, the short duration of single-shot local anesthetics often requires early postoperative opioid use, leading to adverse effects like nausea and respiratory depression. In a resource-constrained healthcare system, utilizing affordable adjuvants to extend nerve block duration is crucial. Dexamethasone and tramadol are inexpensive and widely available in Pakistani hospitals, yet there is limited local evidence comparing their efficacy for supraclavicular brachial plexus blocks. This study aims to provide context-specific data to help anesthesiologists in Pakistan make informed choices about adjuvants, improving pain management, patient satisfaction, and resource use.

Methodology

This comparative study was conducted in the Department of Anesthesia at Aziz Bhatti Shaheed Teaching Hospital, Gujrat, over a period of 12 months, from April 2024 to March 2025. A total of 70 patients scheduled

for elective arm and forearm surgeries under supraclavicular brachial plexus block were enrolled. The sample size was calculated using a WHO sample size calculator, using the expected difference in analgesia duration between the two adjuvants from previously published literature, with a confidence level of 95% and a power of 80%. Patients were allocated into two equal groups of 35 each using a non-probability consecutive sampling technique with alternate assignment to ensure equal distribution.

Patients aged 18 to 60 years, of either gender, belonging to the American Society of Anesthesiologists (ASA) physical status I and II, and scheduled for upper-limb surgery (arm or forearm) were included in the study. Patients with known hypersensitivity to local anesthetics, dexamethasone, or tramadol, those with coagulopathy, infection at the injection site, peripheral neuropathy, severe systemic disease (ASA III or above), pregnancy, or refusal to participate were excluded. Written informed consent was obtained from all participants prior to enrollment, and ethical approval was obtained from the hospital's Institutional Review Board.

All patients underwent pre-anesthetic evaluation, including history, clinical examination, and routine laboratory investigations. Standard monitoring, including non-invasive blood pressure, pulse rate, electrocardiography, and oxygen saturation, was applied in the operating room. Intravenous access was secured, and patients were preloaded with intravenous fluids as per institutional protocol. The supraclavicular brachial plexus block was performed under aseptic conditions using a standardized landmark or ultrasound-guided technique by an experienced anesthesiologist to minimize procedural variability.

In Group A, patients received 30 ml of 0.5% bupivacaine combined with 8 mg (2 ml) dexamethasone, while in Group B, patients received 30 ml of 0.5% bupivacaine combined with 100 mg (2 ml) tramadol. The total volume of the injectate was kept constant in both groups. After administration of the block, patients were assessed for the onset of sensory and motor blockade at regular intervals. Sensory block was evaluated using the pinprick method in the distribution of relevant nerves, while motor block was assessed using a modified Bromage scale for the upper limb.

The primary outcome measures included onset time and duration of sensory and motor blockade, as well as duration of postoperative analgesia, defined as the time from block administration to the first request for rescue analgesia. Secondary outcomes included postoperative pain scores assessed using the Visual Analogue Scale (VAS) at 2, 6, 12, and 24 hours, total analgesic consumption within 24 hours, and incidence of adverse effects such as nausea, vomiting, hypotension, bradycardia, and sedation. Hemodynamic parameters were recorded intraoperatively and in the immediate postoperative period at regular intervals.

Data were collected using a structured proforma and entered into SPSS version 26 for analysis. Quantitative variables were presented as mean ± standard deviation, while qualitative variables were expressed as frequency and percentage. An independent sample t-test was used to compare continuous variables between the two groups, while chi-square or Fisher's exact test was applied for categorical variables. Post-stratification analysis was performed to assess the effect of age, gender, and type of surgery on duration of analgesia. A p-value of ≤0.05 was considered statistically significant.

Results

The overall mean age of the study population was 38.9 ± 11.6 years, and most participants were male, reflecting the usual case mix of upper-limb trauma and elective orthopedic procedures seen in tertiary care hospitals in Pakistan. Baseline demographic and clinical characteristics were comparable between the two groups, with no statistically significant differences in age, gender distribution, body mass index, ASA status, or duration of surgery, suggesting an appropriate balance for outcome comparison. (Table 1)

Table 1. Baseline demographic and clinical characteristics of patients undergoing supraclavicular plexus block

Variable	Dexamethasone + Bupivacaine (n=35)	Tramadol + Bupivacaine (n=35)	p-value
Age (years), mean ± SD	38.1 ± 11.2	39.7 ± 12.0	0.564
Male gender, n (%)	24 (68.6%)	23 (65.7%)	0.796
Female gender, n (%)	11 (31.4%)	12 (34.3%)	0.796
Body mass index (kg/m²), mean ± SD	25.4 ± 3.2	25.9 ± 3.5	0.528
ASA I, n (%)	21 (60.0%)	19 (54.3%)	0.629
ASA II, n (%)	14 (40.0%)	16 (45.7%)	0.629
Duration of surgery (minutes), mean ± SD	84.6 ± 18.7	87.1 ± 20.3	0.595
Right-sided surgery, n (%)	20 (57.1%)	18 (51.4%)	0.632
Arm surgery, n (%)	16 (45.7%)	15 (42.9%)	0.812
Forearm surgery, n (%)	19 (54.3%)	20 (57.1%)	0.812

The block characteristics showed that both adjuvants produced effective anesthesia; however, dexamethasone was associated with a modestly earlier onset of both sensory and motor blockade compared with tramadol. Although the difference in onset times was statistically significant, the more clinically relevant distinction was observed in block duration. Patients receiving dexamethasone had substantially prolonged sensory block, motor block, and postoperative analgesia compared with those receiving tramadol. These findings suggest that dexamethasone was superior in sustaining the anesthetic effect of bupivacaine in the supraclavicular plexus block. (Table 2)

Table 2. Comparison of block characteristics between study groups

Variable	Dexamethasone + Bupivacaine (n=35)	Tramadol + Bupivacaine (n=35)	p-value
Onset of sensory block (minutes), mean ± SD	11.2 ± 2.4	13.1 ± 2.8	0.003
Onset of motor block (minutes), mean ± SD	15.6 ± 3.1	17.9 ± 3.5	0.005
Duration of sensory block (minutes), mean ± SD	812.4 ± 108.6	641.8 ± 96.3	<0.001
Duration of motor block (minutes), mean ± SD	694.2 ± 101.7	548.9 ± 88.4	<0.001
Duration of analgesia (minutes), mean ± SD	928.6 ± 121.4	716.5 ± 104.9	<0.001
Time to first rescue analgesia (hours), mean ± SD	15.5 ± 2.0	11.9 ± 1.8	<0.001

Postoperative pain assessment further supported the analgesic advantage of dexamethasone. Pain scores were similar in the immediate postoperative period, but from 6 hours onward, patients in the dexamethasone group consistently demonstrated lower visual analogue scale scores. At 12 and 24 hours, the between-group difference became more pronounced, indicating more sustained pain control with dexamethasone. In addition, fewer patients in the dexamethasone arm required early rescue analgesia, and the total

analgesic consumption during the first 24 hours was lower than in the tramadol group. (Table 3)

Table 3. Postoperative pain scores and analgesic requirement

Variable	Dexamethasone + Bupivacaine (n=35)	Tramadol + Bupivacaine (n=35)	p-value
VAS at 2 hours, mean ± SD	0.8 ± 0.7	1.0 ± 0.8	0.241
VAS at 6 hours, mean ± SD	1.6 ± 0.9	2.4 ± 1.1	0.001
VAS at 12 hours, mean ± SD	2.8 ± 1.1	4.1 ± 1.3	<0.001
VAS at 24 hours, mean ± SD	3.6 ± 1.2	4.8 ± 1.4	<0.001
Patients requiring rescue analgesia within 12 hours, n (%)	8 (22.9%)	21 (60.0%)	0.002
Total 24-hour rescue analgesic doses, mean ± SD	1.2 ± 0.6	2.0 ± 0.8	<0.001

Perioperative hemodynamic parameters remained stable in both groups, with no clinically important intergroup difference in pulse rate, systolic blood pressure, diastolic blood pressure, or oxygen saturation during surgery and early recovery. Adverse events were infrequent overall. Nausea and vomiting were observed more often in the tramadol group. At the same time, no serious complications such as pneumothorax, local anesthetic systemic toxicity, persistent neurological deficit, or respiratory compromise were recorded in either group. This safety profile indicates that both adjuvants were generally well tolerated, although dexamethasone was associated with fewer minor side effects. (Table 4)

Table 4. Perioperative hemodynamic profile and adverse events

Variable	Dexamethasone + Bupivacaine (n=35)	Tramadol + Bupivacaine (n=35)	p-value
Intraoperative pulse rate (beats/min), mean ± SD	78.6 ± 8.2	80.4 ± 8.9	0.383
Intraoperative systolic BP (mmHg), mean ± SD	124.8 ± 10.6	126.9 ± 11.1	0.421
Intraoperative diastolic BP (mmHg), mean ± SD	78.9 ± 7.4	80.1 ± 7.8	0.511
SpO_2 (%), mean ± SD	98.4 ± 1.1	98.1 ± 1.3	0.297
Nausea/vomiting, n (%)	2 (5.7%)	7 (20.0%)	0.072
Sedation, n (%)	1 (2.9%)	4 (11.4%)	0.164
Bradycardia, n (%)	1 (2.9%)	2 (5.7%)	0.554
Hypotension, n (%)	1 (2.9%)	2 (5.7%)	0.554
Block failure requiring conversion, n (%)	1 (2.9%)	2 (5.7%)	0.554
Serious complication, n (%)	0	0	—

Subgroup assessment showed that the prolongation of analgesia with dexamethasone remained consistent across age groups, gender, and type of surgery. The benefit was particularly evident in male patients, patients aged 18 to 40 years, and those undergoing forearm procedures, although no significant interaction effect was seen across strata. This suggests that the superiority of dexamethasone was robust and not limited to a specific patient subgroup. (Table 5)

Table 5. Stratified comparison of prolonged analgesia (>12 hours) between groups

Stratification variable	Dexamethasone + Bupivacaine n/N (%)	Tramadol + Bupivacaine n/N (%)	p-value
Age 18–40 years	19/21 (90.5%)	10/19 (52.6%)	0.008
Age >40 years	11/14 (78.6%)	6/16 (37.5%)	0.023
Male	22/24 (91.7%)	12/23 (52.2%)	0.003
Female	8/11 (72.7%)	4/12 (33.3%)	0.091
Arm surgeries	13/16 (81.3%)	7/15 (46.7%)	0.045
Forearm surgeries	17/19 (89.5%)	9/20 (45.0%)	0.004

Overall, the results demonstrate that dexamethasone, when used as an adjuvant to bupivacaine in supraclavicular brachial plexus block for arm and forearm surgeries, provided significantly longer sensory and motor blockade and postoperative analgesia than tramadol, while maintaining a comparable hemodynamic profile and a lower incidence of minor adverse effects. These findings support dexamethasone as the more effective adjuvant for prolonging block duration and improving postoperative pain control in this patient population.

Discussion

The present study demonstrates that dexamethasone, when used as an adjuvant to bupivacaine in supraclavicular brachial plexus block, provides significantly superior anesthetic and analgesic outcomes compared to tramadol. These findings are consistent with previously published literature and support the preferential use of dexamethasone in regional anesthesia.

Regarding the onset of blockade, dexamethasone was associated with earlier sensory and motor block. Nagar et al. reported significantly faster onset with dexamethasone compared to tramadol (1). Similarly, Pandey and Chandra observed shorter onset times in the dexamethasone group (3). Marathe et al. attributed this to the synergistic effect of dexamethasone with local anesthetics and its vasoconstrictive action (8). Vaidya et al. further supported improved onset characteristics with dexamethasone (6).

The duration of sensory and motor blockade was significantly prolonged with dexamethasone in the present study. Islam et al. demonstrated increased motor block duration with dexamethasone (2). Kore et al. reported that dexamethasone provides a longer block duration by inhibiting nociceptive C-fiber transmission (7). Schubert et al., in a large meta-analysis, identified dexamethasone as the most effective adjuvant for prolonging analgesia (11).

Postoperative analgesia duration was also significantly longer with dexamethasone. Nagar et al. reported delayed requirement for rescue analgesia with dexamethasone (1). Pandey and Chandra also observed a

longer duration of analgesia than with tramadol (3). Mughal et al. demonstrated that dexamethasone significantly prolongs analgesia and reduces opioid consumption (5).

Patients receiving dexamethasone had lower postoperative pain scores and reduced analgesic requirements. Cherian et al. reported a marked reduction in total analgesic consumption with dexamethasone (13). Iqbal et al. also demonstrated improved analgesic efficacy with dexamethasone compared to other adjuvants (15).

Both adjuvants maintained stable hemodynamic parameters, although tramadol was associated with a higher incidence of nausea and vomiting. Khaleeq et al. reported minimal hemodynamic changes with dexamethasone (10). Kamble et al. noted a higher incidence of adverse effects with tramadol compared to other adjuvants (4).

The superior efficacy of dexamethasone may be explained by its multifactorial mechanism of action. Islam et al. suggested that dexamethasone prolongs nerve blockade through vasoconstriction and anti-inflammatory effects (2). Vaidya et al. reported inhibition of nociceptive impulse transmission as another mechanism (6). In contrast, tramadol acts primarily through central pathways, which may explain its comparatively limited effectiveness (11).

Despite these findings, this study has limitations, including a single-center design and a relatively small sample size. Further multicenter studies are recommended.

Conclusion

Dexamethasone significantly enhances the efficacy of supraclavicular brachial plexus block compared with tramadol, providing earlier onset, markedly prolonged analgesia, and better postoperative pain control, with fewer adverse effects. These findings support the routine use of dexamethasone as a preferred adjuvant to bupivacaine in upper limb surgeries, particularly in resource-limited settings where optimizing analgesia and reducing opioid requirements are essential.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-ABSHGJ-0112-25)

Consent for publication
Approved

Funding
Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

NS (PGR)
Manuscript drafting, Study Design,
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Review of Literature, Data entry, Data analysis, and drafting articles.
AJM (PGR)
Conception of Study, Development of Research Methodology Design,
HA (PGR)
Study Design, manuscript review, critical input.
DA (PGR),
Manuscript drafting, Study Design,

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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