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Fentanyl and Dexamethasone as Adjuvants to Bupivacaine-Lidocaine in Landmark-Guided Supraclavicular Brachial Plexus Block: A Comparative Study in Bangladesh

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Abstract

Background: Supraclavicular brachial plexus block is an effective regional anesthetic technique for upper-limb surgery, but the short duration of local anesthetics remains a limitation. Dexamethasone and fentanyl may improve block quality and prolong analgesia, though evidence on their combined use in landmark-guided block is limited in Bangladesh. **Aim of the study:** This study compared the efficacy of bupivacaine-lidocaine alone with bupivacaine-lidocaine plus fentanyl and dexamethasone in landmark-guided supraclavicular brachial plexus block. **Methods:** This retrospective comparative study was conducted in the Department of Anesthesiology, Gazi Medical College Hospital, Khulna, Bangladesh, from January to December 2025. Hospital records of 60 adult patients undergoing upper-limb surgery under landmark-guided supraclavicular brachial plexus block were reviewed, with 30 patients in each group. Group A received bupivacaine-lidocaine, while Group B received bupivacaine-lidocaine with fentanyl and dexamethasone. Data on block characteristics, analgesic duration, pain scores, hemodynamic parameters, and complications were collected from perioperative records. **Results:** Baseline and block performance characteristics were comparable between the groups. Compared with Group A, Group B showed a faster onset of sensory block (7.1±1.9 vs 9.8±2.4 minutes) and motor block (10.9±2.5 vs 14.6±3.1 minutes). Group B also had significantly longer duration of sensory block (332.6±21.4 vs 218.4±16.7 minutes), motor block (287.9±18.6 vs 194.7±15.3 minutes), and analgesia (356.4±19.7 vs 236.2±14.8 minutes), with $p<0.001$ for all. The need for supplementary intraoperative analgesia was lower in Group B (3.3% vs 20.0%). Fewer patients in Group B required rescue analgesia within 24 hours (60.0% vs 86.7%), and the time to first rescue analgesia was longer (348.7±22.6 vs 228.4±16.9 minutes). Hemodynamic parameters were comparable between the groups, and no major complications were observed. In addition, Group B had better block quality and higher patient satisfaction scores (8.8±1.0 vs 7.1±1.3). **Conclusion:** The addition of fentanyl and dexamethasone to bupivacaine-lidocaine in landmark-guided supraclavicular brachial plexus block provided faster block onset, prolonged analgesia, reduced postoperative pain and rescue analgesic requirement, and improved patient satisfaction, without major complications compared to bupivacaine-lidocaine alone.

Keywords: Supraclavicular brachial plexus block, Bupivacaine-lidocaine, Fentanyl, Dexamethasone, Postoperative analgesia.

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Introduction

Upper limb surgery, such as for fractures, soft-tissue injury, or other orthopedic procedures, often requires anesthetic techniques that ensure reliable operating conditions and strong postoperative analgesia. Regional anesthesia is increasingly valued because it provides dense intraoperative anesthesia, reduces surgical stress, decreases postoperative nausea and vomiting, lowers systemic opioid use, and can improve recovery compared with general anesthesia.[1,2] Within brachial plexus techniques, the supraclavicular approach is especially useful for surgeries distal to the shoulder, as the neural elements are closely packed at this level, allowing broad, reliable upper-limb anesthesia with a single injection.[1]

The importance of optimizing upper-limb anesthesia is amplified by the wider burden of musculoskeletal trauma in low- and middle-income countries. A systematic review of low and lower-middle-income countries highlighted the substantial, undermeasured burden of musculoskeletal injury, while a recent review of global orthopedic inequities emphasized that trauma and care gaps remain concentrated in resource-constrained settings.[3,4] Regional data show that upper-limb injuries make up a significant proportion of orthopedic admissions: in a 2024 Kenyan tertiary hospital study, upper-limb injuries accounted for 26.9% of orthopedic inpatients.[5] In Bangladesh, road traffic injury is a major cause of hospitalization and trauma burden, and qualitative evidence indicates persistent constraints in facility-based trauma care pathways.[6,7] In such settings, effective peripheral nerve block strategies are not only anesthetic choices but also key to optimizing perioperative resources.

Despite the advantages of supraclavicular brachial plexus block, the limited duration of local anesthetics remains a drawback, especially when prolonged intraoperative pain control is needed. Therefore, various adjuvants have been explored. Dexamethasone is consistently associated with a faster onset, longer block duration, and extended postoperative analgesia in supraclavicular block studies.[8,9] Fentanyl has also been used perineurally; recent evidence suggests it improves motor onset and prolongs block duration, though to a lesser extent, and may increase minor adverse effects such as nausea, vomiting, and pruritus.[10] These differences make it clinically relevant to compare and combine these agents.

Evidence from Bangladesh adds further rationale. Local studies have shown that dexamethasone, when combined with bupivacaine-lignocaine, can prolong analgesia more effectively than fentanyl used with bupivacaine-lignocaine. At the same time, newer international work has begun to explore combination adjunct strategies, suggesting that combining agents may further improve postoperative analgesia. However, most previous studies compare only single adjuvants or differ in guidance technique or surgical context. This indicates an evidence gap in assessing whether combining fentanyl and dexamethasone with bupivacaine-lidocaine, compared directly to bupivacaine-lidocaine alone, provides additional benefit during landmark-guided supraclavicular block in Bangladeshi hospitals. Therefore, the present study aimed to compare the efficacy of bupivacaine-lidocaine alone with bupivacaine-lidocaine plus fentanyl and dexamethasone in landmark-guided supraclavicular brachial plexus block.

Materials and methods

This retrospective comparative study was conducted in the Department of Anesthesiology, Gazi Medical College, Khulna, Bangladesh, over one year from January to December 2025. The study reviewed hospital records of patients who underwent upper limb surgery under landmark-guided supraclavicular brachial plexus block during the study period. During the study period, 60 patients were divided into two groups based on the anesthetic regimen documented in the anesthesia record, with 30 patients in each group. Group A received a mixture of bupivacaine and lidocaine, whereas Group B received bupivacaine and lidocaine with fentanyl (25–75 µg, dose selected based on body weight and clinician preference) and dexamethasone (5 mg) as adjuvants. A total volume of 30 mL of anesthetic solution was administered using a landmark-based supraclavicular approach with a 22G needle. Adult patients with complete perioperative records were included. Cases with incomplete documentation, failed blocks requiring immediate conversion to general anesthesia, coagulopathy, local infection at the injection site, allergy to study drugs, or major systemic instability were excluded.

Data were collected from hospital records, anesthesia charts, operative records, recovery notes, and postoperative monitoring sheets using a predesigned data collection form. Variables included age, sex, body weight, ASA physical status, type and duration of postoperative pain scores, rescue analgesic requirement, and complications. Data were entered and analyzed using standard statistical software (SPSS, v. 26.0). Continuous variables were expressed as mean ± SD and compared using the independent sample t-test, while categorical variables were presented as frequency and percentage and compared using the chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant. Institutional ethical approval was obtained, and confidentiality of patient data was ensured.

Results

Table 01 shows comparable baseline characteristics between groups. The mean age was 41.3 ± 10.8 years in Group A and 42.1 ± 11.2 years in Group B. Most patients were male: 70.0% in Group A, 66.7% in Group B. Mean BMI was similar (23.4 ± 2.9 vs 23.9 ± 3.1 kg/m²). Most were ASA class I (60.0% in Group A, 56.7% in Group B). The block was more often performed on the right (56.7% in Group A, 60.0% in Group B). Surgery duration was also similar (72.4 ± 14.6 vs 74.1 ± 15.3 minutes). No baseline variable differed significantly (all p values > 0.05).

Table 01: Baseline characteristics of the study participants

Variables	Category	Group A (n = 30)	Group B (n = 30)	p-value
		n (%)	n (%)	
Age (years)	mean ± SD	41.3 ± 10.8	42.1 ± 11.2	0.781
Gender	Male	21 (70.0)	20 (66.7)	0.781
	Female	9 (30.0)	10 (33.3)	0.781
BMI (kg/m²)	mean ± SD	23.4 ± 2.9	23.9 ± 3.1	0.518
ASA	Class I	18 (60.0)	17 (56.7)	0.793
	Class II	12 (40.0)	13 (43.3)	0.793
Block side	Right	17 (56.7)	18 (60.0)	0.795
	Left	13 (43.3)	12 (40.0)	0.795
Duration of surgery (min)	mean ± SD	72.4 ± 14.6	74.1 ± 15.3	0.662

Table 02 shows that most block-related characteristics were similar between the two groups. The mean time required to perform the block was 6.6 ± 1.3 minutes in Group A and 6.8 ± 1.4 minutes in Group B, while the mean number of needle attempts was 1.5 ± 0.7 and 1.4 ± 0.6, respectively. A successful block at the first attempt was achieved in 76.7% of patients in Group A, and 83.3% in Group B. Complete sensory block was achieved in 90.0% of Group A and 96.7% of Group B, and complete motor block in 86.7% and 93.3%, respectively. The need for supplementary intraoperative analgesia was higher in Group A (20.0%) than in Group B (3.3%), and this was the only statistically significant difference (p = 0.044).

Table 02: Block-related characteristics between the study groups

Variables	Group A (n = 30)	Group B (n = 30)	p-value
	mean ± SD/n (%)	mean ± SD/n (%)	
Time required to perform block (min)	6.6 ± 1.3	6.8 ± 1.4	0.571
Number of needle attempts (mean ± SD)	1.5 ± 0.7	1.4 ± 0.6	0.548
Successful block at first attempt	23 (76.7)	25 (83.3)	0.519
Complete sensory block achieved	27 (90.0)	29 (96.7)	0.301
Complete motor block achieved	26 (86.7)	28 (93.3)	0.389
Need for supplementary intraoperative analgesia	6 (20.0)	1 (3.3)	0.044

The onset of sensory block was shorter in Group B than in Group A, 7.1 ± 1.9 minutes vs 9.8 ± 2.4 minutes. Similarly, the onset of motor block was shorter in Group B, 10.9 ± 2.5 minutes, compared with 14.6 ± 3.1 minutes in Group A. In terms of duration, Group B had a markedly prolonged sensory block (332.6 ± 21.4 minutes) compared with Group A (218.4 ± 16.7 minutes). The duration of motor block was likewise longer in Group B, 287.9 ± 18.6 minutes vs 194.7 ± 15.3 minutes. Furthermore, the duration of analgesia was longer in Group B (356.4 ± 19.7 minutes) than in Group A (236.2 ± 14.8 minutes). All differences were statistically significant ($p < 0.001$).

Table 03: Comparison of sensory and motor block profile

Variables	Group A (n = 30)	Group B (n = 30)	p-value
	mean ± SD	mean ± SD	
Onset time of sensory block (min)	9.8 ± 2.4	7.1 ± 1.9	<0.001
Onset time of motor block (min)	14.6 ± 3.1	10.9 ± 2.5	<0.001
Duration of sensory block (min)	218.4 ± 16.7	332.6 ± 21.4	<0.001
Duration of motor block (min)	194.7 ± 15.3	287.9 ± 18.6	<0.001
Duration of analgesia (min)	236.2 ± 14.8	356.4 ± 19.7	<0.001

Table 04 shows that Visual Analogue Scale (VAS) pain scores were similar at 0 and 1 hour, with no statistically significant difference ($p > 0.05$). From 2 hours onward, pain scores were significantly lower in Group B ($p < 0.05$). At 2 hours, VAS was 1.2 ± 0.9 in Group A vs 0.7 ± 0.6 in Group B; at 4 hours, it was 2.4 ± 1.0 vs 1.2 ± 0.8; and at 6 hours, it was 3.9 ± 1.1 vs 1.8 ± 0.9. Group B had better postoperative pain control.

Table 04: Postoperative pain score comparison by VAS

Time after surgery	Group A (n = 30)	Group B (n = 30)	p-value
	Mean ± SD		
0 hour	0.3 ± 0.5	0.2 ± 0.4	0.396
1 hour	0.6 ± 0.7	0.4 ± 0.6	0.238
2 hours	1.2 ± 0.9	0.7 ± 0.6	0.016
4 hours	2.4 ± 1.0	1.2 ± 0.8	<0.001
6 hours	3.9 ± 1.1	1.8 ± 0.9	<0.001

Rescue analgesia within 24 hours was needed in 26 patients (86.7%) in Group A, whereas only 18 patients (60.0%) in Group B required it. Additionally, the time to first rescue analgesic was substantially longer in Group B (348.7 ± 22.6 minutes) compared to Group A (228.4 ± 16.9 minutes), highlighting Group B's improved outcome for both measures. In addition, total analgesic consumption over 24 hours was higher in Group A (156.7 ± 41.5 mg diclofenac equivalent) than in Group B (92.3 ± 35.8 mg). The number of rescue analgesic doses followed the same trend, with Group A receiving 2.3 ± 0.8 doses, compared with 1.3 ± 0.6 in Group B. All differences were statistically significant, with the strongest significance observed for time to first rescue analgesic, total analgesic consumption, and number of rescue doses ($p < 0.001$).

Table 05: Postoperative analgesic requirement

Variables	Group A (n = 30)	Group B (n = 30)	p-value
	mean ± SD/n (%)	mean ± SD/n (%)	
Patients requiring rescue analgesia within 24 hours, n (%)	26 (86.7)	18 (60.0)	0.018
Time to first rescue analgesic (min)	228.4 ± 16.9	348.7 ± 22.6	<0.001
Total analgesic consumption in 24 hours (mg diclofenac equivalent)	156.7 ± 41.5	92.3 ± 35.8	<0.001
Number of rescue analgesic doses in 24 hours	2.3 ± 0.8	1.3 ± 0.6	<0.001

Table 06 shows that hemodynamic parameters were comparable between the two groups at baseline and during surgery. At baseline, the mean pulse rate was 82.6 ± 8.3 beats/min in Group A and 81.9 ± 7.9 beats/min in Group B. Mean systolic BP was 124.8 ± 10.7 mmHg vs 123.6 ± 11.1 mmHg, mean diastolic BP was 78.4 ± 7.6 mmHg vs 77.9 ± 7.2 mmHg, and mean SpO_2 was 98.2 ± 0.9% vs 98.3 ± 0.8%. Intraoperatively, the mean pulse rate was 79.8 ± 7.5 beats/min in Group A and 77.6 ± 7.1 beats/min in Group B, while systolic BP was 121.9 ± 9.8 mmHg vs 119.8 ± 10.2 mmHg, diastolic BP was 76.6 ± 6.9 mmHg vs 75.1 ± 6.7 mmHg, and SpO_2 was 98.1 ± 0.8% vs 98.2 ± 0.7%. None of these differences was statistically significant, with all p-values> 0.05.

Table 06: Hemodynamic parameters between the groups

Variables	Group A (n = 30)	Group B (n = 30)	p-value
	Mean ± SD		
Baseline pulse rate (beats/min)	82.6 ± 8.3	81.9 ± 7.9	0.739
Baseline systolic BP (mmHg)	124.8 ± 10.7	123.6 ± 11.1	0.671
Baseline diastolic BP (mmHg)	78.4 ± 7.6	77.9 ± 7.2	0.795
Baseline SpO_2 (%)	98.2 ± 0.9	98.3 ± 0.8	0.648
Intraoperative pulse rate (beats/min)	79.8 ± 7.5	77.6 ± 7.1	0.247
Intraoperative systolic BP (mmHg)	121.9 ± 9.8	119.8 ± 10.2	0.42
Intraoperative diastolic BP (mmHg)	76.6 ± 6.9	75.1 ± 6.7	0.398
Intraoperative SpO_2 (%)	98.1 ± 0.8	98.2 ± 0.7	0.611

Hypotension occurred in 3.3% of Group A and 6.7% of Group B; bradycardia occurred in 3.3% of Group B only. Nausea was more common in Group B (16.7% vs 6.7%), while vomiting occurred in only 3.3% of Group A. Pruritus (10.0%) and mild sedation (13.3%) were observed only or more frequently in Group B. Hematoma at the puncture site occurred equally in both groups (3.3%), and Horner's syndrome was noted in 6.7% of Group A and 10.0% of Group B. No patient in either group developed respiratory depression, local anaesthetic systemic toxicity, or pneumothorax. All p-values were > 0.05.

Table 07: Adverse effects and complications

Complications	Group A (n = 30)	Group B (n = 30)	p-value
	n (%)	n (%)	
Hypotension	1 (3.3)	2 (6.7)	0.554
Bradycardia	0 (0.0)	1 (3.3)	0.313
Nausea	2 (6.7)	5 (16.67)	0.228
Vomiting	1 (3.3)	0 (0.0)	0.313
Respiratory depression	0 (0.0)	0 (0.0)	1
Pruritus	0 (0.0)	3 (10.0)	0.076
Mild sedation	1 (3.3)	4 (13.3)	0.161
Local anesthetic systemic toxicity	0 (0.0)	0 (0.0)	1
Pneumothorax	0 (0.0)	0 (0.0)	1
Hematoma at the puncture site	1 (3.3)	1 (3.3)	1
Horner's syndrome	2 (6.7)	3 (10.0)	0.64

Table 08 shows that overall block quality and patient satisfaction were better in Group B than in Group A. Excellent block quality was achieved in 60.0% of Group B, compared with 30.0% in Group A, a statistically significant difference (p = 0.019). Good block quality was observed in 33.3% of Group B and 40.0% of Group A, while fair block quality was seen in 6.7% and 20.0%, respectively. Poor block quality occurred only in Group A (10.0%) and not in Group B. The mean patient satisfaction score was significantly higher in Group B (8.8 ± 1.0) than in Group A (7.1 ± 1.3; p < 0.001).

Table 08: Overall block quality and patient satisfaction

Variables	Group A (n = 30)	Group B (n = 30)	p-value
	mean ± SD/n (%)	mean ± SD/n (%)	
Excellent block quality	9 (30.0)	18 (60.0)	0.019
Good block quality	12 (40.0)	10 (33.3)	0.592
Fair block quality	6 (20.0)	2 (6.7)	0.129
Poor block quality	3 (10.0)	0 (0.0)	0.076
Patient satisfaction score (out of 10)	7.1 ± 1.3	8.8 ± 1.0	<0.001

Discussion

The present study showed that adding fentanyl and dexamethasone to bupivacaine-lidocaine improved both block performance and postoperative analgesia. Compared with Group A, Group B had a faster onset of sensory block (7.1 ± 1.9 vs 9.8 ± 2.4 minutes) and motor block (10.9 ± 2.5 vs 14.6 ± 3.1 minutes). It also had a longer duration of sensory block (332.6 ± 21.4 vs 218.4 ± 16.7 minutes), motor block (287.9 ± 18.6 vs 194.7 ± 15.3 minutes), and analgesia (356.4 ± 19.7 vs 236.2 ±

14.8 minutes). Rescue analgesia was required less often in Group B (60.0% vs 86.7%); the time to first rescue analgesic was longer (348.7 ± 22.6 vs 228.4 ± 16.9 minutes). Total 24-hour analgesic consumption was lower (92.3 ± 35.8 vs 156.7 ± 41.5 mg diclofenac equivalent), and patient satisfaction was higher (8.8 ± 1.0 vs 7.1 ± 1.3). Hemodynamic parameters remained comparable, and no major complication was observed.

These findings are broadly consistent with previous studies showing that dexamethasone improves the quality and duration of brachial plexus block. Meta-analyses by Choi et al. and Knezevic et al. found that dexamethasone significantly prolongs sensory block, motor block, and postoperative analgesia.[11,12] Likewise, randomized supraclavicular block studies reported faster onset and longer analgesia when dexamethasone was added to long-acting local anesthetics.[8,13-16] Dexamethasone prolongs analgesia through anti-inflammatory effects and reduced local anesthetic absorption, while fentanyl may act on peripheral opioid receptors. Therefore, the longer sensory and motor block durations observed in Group B in the present study are in line with the established pharmacologic benefit of dexamethasone as a peripheral nerve block adjuvant.

Recent evidence further supports these conclusions. For example, Baeriswyl et al. demonstrated that perineural dexamethasone generally produces greater block analgesia than systemic administration.[17] Kirkham et al. suggested lower doses may already deliver near-maximal benefit.[18] Multiple studies, including those by Bei et al. and Sehmbi et al., confirm that dexamethasone, regardless of route, consistently extends analgesic duration for brachial plexus block.[19,20] Zufferey et al. showed a dose-response relationship[21], and Albrecht et al. indicated that the additional effect of perineural compared to intravenous dosing may be modest in some situations.[22] The present study's analgesia prolongation appears somewhat shorter than in several ultrasound-guided prospective studies, a finding that may reflect differences in technique, local anesthetic mixture, variable fentanyl dosing, or data capture. Nevertheless, the benefits observed are directionally and proportionally comparable across studies. These findings are particularly relevant in low-resource settings where ultrasound guidance is not routinely available.

The fentanyl component of the regimen may also have contributed, especially to earlier onset and better intraoperative comfort, though literature shows its effect is less robust than that of dexamethasone. For instance, Kaur et al. and Dharmarao and Holyachi found that fentanyl improved block characteristics, but dexmedetomidine led to longer analgesia.[23,24] Similarly, Puri et al. noted improved postoperative analgesia with fentanyl-containing supraclavicular blocks[25], while Hashim and Hassan reported fentanyl was inferior to dexmedetomidine and ketamine for postoperative analgesia.[26] In comparison, a meta-analysis by Song et al. found fentanyl modestly prolongs block duration and accelerates motor onset[10], but may increase adverse effects such as nausea and pruritus. In the present study, Group B showed better analgesia but slightly more nausea, pruritus, and mild sedation, though these differences were not statistically significant. Albrecht et al.'s broader indirect comparison suggests dexamethasone is likely the key driver of prolonged analgesia in mixed-adjuvant regimens.[27] Overall, comparisons indicate that adding dexamethasone with or without fentanyl enhances single-shot supraclavicular block quality, reduces postoperative analgesic demand, and improves patient satisfaction, particularly in low-resource settings where landmark-guided techniques remain common.

Limitations of the study

This was a retrospective single-center study with a small sample size and possible record-based bias. The combined use of fentanyl and dexamethasone also prevented the assessment of their separate effects.

Conclusion

The combination of fentanyl and dexamethasone with bupivacaine-lidocaine in landmark-guided supraclavicular brachial plexus block resulted in a more rapid onset of block, prolonged anesthesia and analgesia, lower postoperative pain scores, decreased need for rescue analgesics, and improved patient satisfaction compared to bupivacaine-lidocaine alone. The regimen was hemodynamically stable and was not associated with any major complications.

Recommendations

The combination of fentanyl and dexamethasone with bupivacaine-lidocaine may be considered as an effective adjuvant regimen for landmark-guided supraclavicular brachial plexus block in upper-limb surgery. Larger, prospective, randomized, multicenter studies are recommended to confirm these findings and to evaluate the individual contribution of each adjuvant.

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