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KEY WORDS: Fentanyl adjuvant; Supraclavicular brachial plexus block; Xylocaine with adrenaline; Duration of analgesia; Upper limb surgery.

COMPARISON BETWEEN XYLOCAINE+ADRENALINE VERSUS XYLOCAINE+ADRENALINE WITH FENTANYL AS AN ADJUVANT IN SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK

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ABSTRACT

Aim: To compare the efficacy, onset, duration, and safety profile of fentanyl as an adjuvant versus xylocaine with adrenaline alone in supraclavicular brachial plexus block for upper limb surgeries. **Materials and Methods:** This prospective randomized comparative study included 120 adult patients (ASA I-II) aged 18-65 years undergoing elective upper limb orthopedic surgeries under supraclavicular brachial plexus block. Patients were randomly allocated into two groups: Group F (n=60) received xylocaine with adrenaline plus 50 µg fentanyl as adjuvant, and Group X (n=60) received xylocaine with adrenaline alone. Block characteristics including onset time of sensory and motor blockade, duration of sensory and motor blockade, duration of analgesia, postoperative pain scores (VAS), rescue analgesic requirements, and hemodynamic parameters were recorded and compared between groups. Statistical analysis was performed using SPSS version 22, with $p<0.05$ considered statistically significant. **Results:** Group F demonstrated significantly prolonged duration of sensory blockade (385.2±48.5 min vs 242.3±41.2 min, $p<0.001$) and motor blockade (368.4±52.3 min vs 228.5±38.7 min, $p<0.001$) compared to Group X. Onset time of sensory block was comparable between groups (15.2±3.8 min vs 14.5±4.1 min, $p=0.32$), while motor block onset was slightly delayed in Group F (18.5±4.2 min vs 16.8±3.9 min, $p=0.03$). Postoperative VAS scores at 6 hours were significantly lower in Group F (3.2±1.1 vs 5.8±1.4, $p<0.001$), and total rescue analgesic consumption over 24 hours was reduced by 42% in Group F. Hemodynamic parameters remained stable in both groups with no significant adverse events reported. **Conclusion:** The addition of fentanyl 50 µg as an adjuvant to xylocaine with adrenaline in supraclavicular brachial plexus block significantly prolongs the duration of sensory and motor blockade, extends postoperative analgesia, and reduces rescue analgesic requirements without compromising safety or hemodynamic stability, making it a superior choice for upper limb surgeries requiring extended postoperative pain control.

INTRODUCTION

Supraclavicular brachial plexus block is a widely employed regional anesthetic technique for upper limb surgeries, offering excellent intraoperative anesthesia and postoperative analgesia while avoiding the risks associated with general anesthesia. The technique involves deposition of local anesthetic solution around the brachial plexus trunks at the level of the clavicle, providing dense blockade of the entire upper extremity distal to the shoulder.

The quest for optimal anesthetic regimens has led to extensive research into the use of adjuvants that can enhance the quality, onset, and duration of local anesthetic blocks. Among various adjuvants studied, fentanyl, a potent synthetic opioid, has garnered significant attention due to its favorable pharmacological profile and demonstrated efficacy in peripheral nerve blocks. Fentanyl acts primarily through mu-opioid receptors present on peripheral nerve fibers, providing synergistic analgesic effects when combined with local anesthetics.

Xylocaine (lidocaine) with adrenaline remains a cornerstone agent in regional anesthesia due to its rapid onset, reliable depth of blockade, and the vasoconstrictive properties of adrenaline that prolong the duration of action while reducing systemic absorption. However, the relatively short duration of analgesia provided by xylocaine with adrenaline alone often necessitates additional postoperative analgesic interventions, particularly in procedures requiring extended pain control.

The rationale for combining fentanyl with local anesthetics stems from the complementary mechanisms of action: local anesthetics block sodium channels preventing nerve impulse propagation, while opioids modulate pain transmission through receptor-mediated pathways. This dual mechanism has been shown to produce superior analgesic outcomes compared to either agent alone. Several studies have investigated the role of fentanyl as an adjuvant in brachial plexus blocks with varying results. While some researchers have reported significant prolongation of analgesia duration and improved postoperative pain control, others have found minimal or no significant benefits. These discrepancies may be attributed to differences in study design, fentanyl dosage, local anesthetic type, and patient populations.

A meta-analysis of 12 randomized controlled trials involving 660 patients demonstrated that adjuvant fentanyl significantly prolonged sensory and motor anesthesia duration while accelerating motor block onset, though it was associated with a higher incidence of complications. However, most studies have focused on fentanyl combined with long-acting local anesthetics like bupivacaine or ropivacaine, with limited data available on its use with intermediate-acting agents like xylocaine with adrenaline in supraclavicular approaches.

The present study was designed to address this knowledge gap by conducting a prospective comparative evaluation of fentanyl as an adjuvant versus xylocaine with adrenaline alone in supraclavicular brachial plexus block. We aimed to assess the impact on block characteristics, duration of analgesia, postoperative pain scores, rescue analgesic requirements, and safety profile, thereby providing evidence-based recommendations for clinical practice in upper limb anesthesia.

MATERIALS & METHODS

This prospective randomized comparative study was conducted in the Department of Anesthesiology at a ..... hospital over a period of 18 months, following institutional ethical committee approval and written informed consent from all participants. The study protocol adhered to the Declaration of Helsinki guidelines for clinical research involving human subjects.

Study Population: A total of 120 adult patients aged 18-65

years, belonging to American Society of Anesthesiologists (ASA) physical status I and II, scheduled for elective upper limb orthopedic surgeries under supraclavicular brachial plexus block were enrolled. Exclusion criteria included: patient refusal, known allergy to study drugs, coagulopathy or anticoagulant therapy, neurological deficits in the upper limb, infection at the injection site, BMI >35 kg/m², and chronic pain or opioid use.

Randomization and Group Allocation: Patients were randomly allocated into two groups using computer-generated random number tables with sealed opaque envelopes: Group F (n=60) received xylocaine 1.5% with adrenaline (1:200,000) plus fentanyl 50 µg as adjuvant (total volume 30 ml), and Group X (n=60) received xylocaine 1.5% with adrenaline (1:200,000) alone (total volume 30 ml). Randomization was performed by an independent anesthesiologist not involved in data collection or patient management.

Block Technique: All blocks were performed by experienced anesthesiologists using a standardized supraclavicular approach with peripheral nerve stimulator guidance (PNS, 0.5 mA, 2 Hz). Patients were positioned supine with head turned 45° to the contralateral side. After aseptic preparation and local infiltration with 2% lidocaine, a 22-gauge insulated needle was inserted at the supraclavicular fossa, 2-3 cm lateral to the subclavian artery pulsation, directed caudally and medially. Successful placement was confirmed by eliciting motor responses (finger flexion/extension or wrist movements) at 0.3-0.5 mA.

Study Drugs and Administration: In Group F, the study solution consisted of 20 ml xylocaine 1.5% with adrenaline (1:200,000) plus 10 ml normal saline containing fentanyl 50 µg (total 30 ml). In Group X, the solution comprised 20 ml xylocaine 1.5% with adrenaline (1:200,000) plus 10 ml normal saline (total 30 ml). All study solutions were prepared by a blinded pharmacist and administered slowly with intermittent aspiration to avoid intravascular injection.

Outcome Measures: Primary outcome was duration of analgesia (time from block completion to first request for postoperative analgesic). Secondary outcomes included: onset time of sensory block (time from block completion to loss of pinprick sensation in all dermatomes C5-T1), onset time of motor block (time to grade 3 motor blockade using modified Bromage scale), duration of sensory block (time to return of pinprick sensation), duration of motor block (time to return of motor function), postoperative pain scores using Visual Analog Scale (VAS, 0-10) at 2, 6, 12, and 24 hours, total rescue analgesic consumption over 24 hours (paracetamol 1g IV and tramadol 50mg IV as needed), and hemodynamic parameters (heart rate, systolic/diastolic blood pressure, SpO2) recorded at baseline, 5, 10, 15, 30 minutes, and hourly thereafter.

Postoperative Management: All patients received standardized postoperative care in the recovery room with continuous monitoring. Rescue analgesia was administered on patient request or VAS ≥4, starting with paracetamol 1g IV, followed by tramadol 50mg IV if inadequate pain relief. Patients with severe nausea, vomiting, respiratory depression (SpO2 <92%), or hemodynamic instability were managed per institutional protocols.

OBSERVATIONTABLES

TABLE 1: DEMOGRAPHIC AND BASELINE CHARACTERISTICS

Parameter	Group F (n=60)	Group X (n=60)	p-value
Age (years), mean±SD	42.3±12.5	41.8±13.2	0.78
Gender (M:F), n	35:25	33:27	0.82
Weight (kg), mean±SD	65.2±8.4	64.8±9.1	0.79
Height (cm), mean±SD	165.3±7.2	164.8±7.8	0.72
BMI (kg/m²), mean±SD	23.8±2.4	23.6±2.6	0.68
ASA I:II, n	42:18	40:20	0.75
Duration of surgery (min), mean±SD	95.3±28.5	93.8±30.2	0.76

Data presented as mean±SD or number (n). BMI: Body Mass Index; ASA: American Society of Anesthesiologists. No significant differences in baseline characteristics between groups.

TABLE 2: BLOCK CHARACTERISTICS AND ONSET TIMES

Parameter	Group F (n=60)	Group X (n=60)	p-value
Onset of sensory block (min), mean±SD	15.2±3.8	14.5±4.1	0.32
Onset of motor block (min), mean±SD	18.5±4.2	16.8±3.9	0.03*
Duration of sensory block (min), mean±SD	385.2±48.5	242.3±41.2	<0.001*
Duration of motor block (min), mean±SD	368.4±52.3	228.5±38.7	<0.001*
Duration of analgesia (min), mean±SD	392.5±51.2	248.6±44.3	<0.001*

*Data presented as mean±SD. Statistically significant ($p<0.05$). Group F: fentanyl adjuvant; Group X: xylocaine with adrenaline alone. Note significantly prolonged duration of sensory, motor block, and analgesia in Group F.

TABLE 3: POSTOPERATIVE PAIN SCORES AND ANALGESIC REQUIREMENTS

Parameter	Group F (n=60)	Group X (n=60)	p-value
VAS at 2 hours, mean±SD	2.1±0.8	2.4±0.9	0.08
VAS at 6 hours, mean±SD	3.2±1.1	5.8±1.4	<0.001*
VAS at 12 hours, mean±SD	4.5±1.3	7.2±1.5	<0.001*
VAS at 24 hours, mean±SD	3.8±1.2	5.6±1.4	<0.001*
Paracetamol consumption (g), mean±SD	2.8±0.9	4.1±1.2	<0.001*
Tramadol consumption (mg), mean±SD	65.3±28.5	125.4±42.3	<0.001*
Total rescue analgesia episodes, median (IQR)	2 (1-3)	4 (3-5)	<0.001*

*Data presented as mean±SD or median (IQR). VAS: Visual Analog Scale (0-10). *Statistically significant ($p<0.05$). Group F showed significantly lower pain scores and reduced analgesic requirements.*

TABLE 4: HEMODYNAMIC PARAMETERS AND ADVERSE EVENTS

Parameter	Group F (n=60)	Group X (n=60)	p-value
Baseline HR (bpm), mean±SD	78.5±9.2	77.8±8.8	0.68
Lowest HR (bpm), mean±SD	72.3±8.5	73.5±9.1	0.45
Baseline SBP (mmHg), mean±SD	128.5±12.3	127.8±11.8	0.74
Lowest SBP (mmHg), mean±SD	118.2±11.5	119.5±12.2	0.55
SpO2 <95%, n (%)	2 (3.3)	1 (1.7)	0.56
Nausea/Vomiting, n (%)	4 (6.7)	3 (5.0)	0.70
Respiratory depression, n (%)	1 (1.7)	0 (0)	0.32
Hypotension, n (%)	3 (5.0)	2 (3.3)	0.65
Pruritus, n (%)	2 (3.3)	0 (0)	0.15

Data presented as mean±SD or number (percentage). HR: Heart Rate; SBP: Systolic Blood Pressure; SpO2: Oxygen Saturation. No significant differences in hemodynamic stability or adverse

events between groups. All complications were mild and managed conservatively.

RESULT

The present study demonstrated that the addition of fentanyl 50 µg as an adjuvant to xylocaine with adrenaline in supraclavicular brachial plexus block produced significant improvements in several key outcome measures compared to xylocaine with adrenaline alone. Both groups were well-matched at baseline with no significant differences in age, gender distribution, weight, height, BMI, ASA status, or duration of surgery, ensuring that observed differences could be attributed to the intervention rather than confounding variables.

The onset time of sensory blockade was comparable between Group F and Group X (15.2±3.8 min vs 14.5±4.1 min, p=0.32), indicating that fentanyl did not delay the initiation of sensory anesthesia. However, motor block onset was slightly but significantly delayed in Group F (18.5±4.2 min vs 16.8±3.9 min, p=0.03), though this difference was clinically marginal (approximately 2 minutes).

Duration of Blockade: The most striking findings were observed in the duration parameters. Group F exhibited significantly prolonged duration of sensory blockade (385.2±48.5 min vs 242.3±41.2 min, p<0.001), representing a 59% increase compared to Group X. Similarly, motor blockade duration was significantly extended in Group F (368.4±52.3 min vs 228.5±38.7 min, p<0.001), a 61% improvement. The duration of analgesia, our primary outcome, was also significantly prolonged in Group F (392.5±51.2 min vs 248.6±44.3 min, p<0.001), demonstrating a 58% increase.

Postoperative VAS pain scores were significantly lower in Group F at 6 hours (3.2±1.1 vs 5.8±1.4, p<0.001), 12 hours (4.5±1.3 vs 7.2±1.5, p<0.001), and 24 hours (3.8±1.2 vs 5.6±1.4, p<0.001), though scores at 2 hours were comparable. Total paracetamol consumption was significantly reduced in Group F (2.8±0.9 g vs 4.1±1.2 g, p<0.001), as was tramadol requirement (65.3±28.5 mg vs 125.4±42.3 mg, p<0.001), representing approximately 48% and 52% reductions respectively. The total number of rescue analgesic episodes was also significantly lower in Group F (median 2 vs 4, p<0.001).

Hemodynamic parameters including heart rate, systolic blood pressure, and oxygen saturation remained stable throughout the study period with no significant differences between groups. Adverse events were infrequent and mild in both groups, with nausea/vomiting (6.7% vs 5.0%, p=0.70), transient hypotension (5.0% vs 3.3%, p=0.65), and pruritus (3.3% vs 0%, p=0.15) being the most common. One patient in Group F experienced mild respiratory depression (SpO2 91%) that resolved with supplemental oxygen, while no respiratory complications occurred in Group X.

These results collectively demonstrate that fentanyl 50 µg as an adjuvant significantly enhances the duration and quality of supraclavicular brachial plexus block with xylocaine and adrenaline while maintaining an acceptable safety profile.

STATISTICAL ANALYSIS

All statistical analyses were performed using SPSS version 22.0 (IBM Corp., Armonk, NY, USA) with a significance level set at =0.05 (two-tailed). Continuous variables were tested for normality. Categorical variables were presented as frequencies and percentages. For normally distributed continuous variables (age, weight, height, BMI, onset times, duration parameters, VAS scores, hemodynamic variables), the independent Student's t-test was employed to compare means between Group F and Group X. Hemodynamic parameters (heart rate, systolic/diastolic blood pressure, SpO2) recorded at multiple time points were analyzed using repeated measures analysis of variance (ANOVA) with time as the within-subjects factor and group as the between-subjects factor to assess changes over time and between-group differences. Data were entered into Microsoft Excel spreadsheets and imported into SPSS for analysis. All analyses were performed by an independent statistician blinded to group allocation to minimize bias.

DISCUSSION

Our study demonstrated that adding fentanyl 50 mcg to xylocaine with adrenaline in supraclavicular brachial plexus block significantly prolonged sensory block, motor block, and postoperative analgesia, while maintaining stable hemodynamics and an acceptable safety profile. These findings support the concept that fentanyl is a useful adjuvant in peripheral nerve blocks, particularly when extended postoperative pain relief is desired. The overall pattern of benefit in our trial is consistent with the broader literature showing that opioid adjuvants can improve block duration and analgesic quality without major safety concerns.

The present results are in close agreement with the randomized comparative study by Kumar et al., who also reported improved block characteristics when fentanyl was used as an adjuvant in brachial plexus block. Although their exact local anesthetic regimen differed from ours, the direction of effect was similar, namely prolonged analgesia and enhanced block performance. This consistency strengthens the argument that fentanyl has an additive or synergistic role when combined with local anesthetics in brachial plexus anesthesia. Our study adds to that evidence by specifically demonstrating these benefits with xylocaine and adrenaline in a supraclavicular approach.

Similarly, Singelyn et al. found that fentanyl improved the quality of supraclavicular brachial plexus block in a randomized double-blind study, supporting the analgesic advantage seen in our trial. Their work is important because it provides early clinical evidence that perineural fentanyl can extend the duration of regional anesthesia. Our findings replicate this benefit in a larger and more contemporary patient cohort, again confirming that fentanyl can meaningfully improve postoperative analgesia in upper limb surgery. The concordance between the two studies suggests that the effect is reproducible across different clinical settings.

Bhatia et al. also showed that addition of fentanyl to xylocaine hydrochloride in supraclavicular block improved analgesic outcomes, which aligns well with our results. In both studies, fentanyl appeared to enhance the duration of block more than it altered onset times. This is particularly relevant clinically because a good adjuvant should ideally extend analgesia without causing a major delay in surgical readiness. Our study followed the same pattern, with sensory onset remaining comparable between groups and only a small delay in motor onset, which was unlikely to be clinically important.

Palaniswamy et al. reported that fentanyl prolonged analgesia in brachial plexus block, again consistent with our findings. Their study, like ours, supports the concept that fentanyl is more effective in prolonging postoperative comfort than in accelerating onset of blockade. This is an important distinction because it highlights the primary value of fentanyl as a duration-enhancing adjuvant rather than an onset-optimizing drug. Our data reinforce this point by showing a marked increase in analgesia duration and a clear reduction in rescue analgesic requirement.

The meta-analysis by Hogan et al. provided higher-level evidence that fentanyl as an adjuvant can prolong sensory and motor anesthesia in upper extremity surgery, although they also noted a possible increase in complications in some

studies. Our findings agree with the efficacy signal in that meta-analysis, but our safety data are reassuring because we observed no serious adverse effects or clinically meaningful hemodynamic instability. This suggests that when fentanyl is used in a controlled dose and in a standardized block technique, the analgesic benefit may outweigh the small risk of minor side effects. Our study therefore adds practical clinical support to the meta-analytic evidence.

When compared with studies involving other local anesthetic agents such as bupivacaine or ropivacaine, our findings remain broadly consistent in showing fentanyl's ability to improve postoperative analgesia. Hassan et al. reported better outcomes when fentanyl was added to lidocaine and bupivacaine combinations, and Sharma et al. also demonstrated favorable results with fentanyl as an adjuvant to ropivacaine. Although those studies used longer-acting anesthetics than ours, the direction of benefit was similar, which suggests that fentanyl's role is not limited to one specific local anesthetic. Our study is particularly valuable because it shows that even with xylocaine and adrenaline, fentanyl still produces a substantial prolongation of analgesia. Compared with studies of alternative adjuvants such as dexamethasone and clonidine, our results suggest that fentanyl offers a reliable and clinically meaningful improvement in postoperative pain control. Narang et al. and El-Hefnawy et al. reported comparative advantages of dexamethasone over fentanyl in some supraclavicular block settings, while other studies have highlighted the long-duration benefit of dexamethasone or clonidine. However, those agents may differ in onset profile, side-effect pattern, and onset-to-duration balance. In contrast, our study shows that fentanyl provides a simple and predictable prolongation of analgesia with minimal physiologic disturbance, making it attractive when rapid block performance and moderate-duration pain control are priorities.

Our study also differs from Kaur et al., who compared adrenaline xylocaine with bupivacaine in bilateral brachial plexus block and highlighted the intrinsic duration advantage of bupivacaine. While bupivacaine generally provides longer analgesia than lidocaine-based regimens, our findings indicate that adding fentanyl can partially compensate for the shorter duration of xylocaine and adrenaline. This is clinically useful in settings where xylocaine is preferred for its rapid onset, cost-effectiveness, or availability. Thus, fentanyl may help bridge the duration gap between shorter-acting and longer-acting local anesthetic strategies.

The safety profile observed in our study is consistent with much of the published literature on fentanyl adjuvants in peripheral nerve blocks. We observed no major hemodynamic instability, and the adverse events were mild and infrequent, including nausea, vomiting, pruritus, and transient respiratory depression in only one patient. This is important because concerns about opioid-related side effects have historically limited wider acceptance of perineural fentanyl. Our results indicate that at the studied dose, fentanyl can be used safely when appropriate monitoring is in place.

In summary, our findings are strongly supported by previous clinical trials and reviews showing that fentanyl improves block duration and postoperative analgesia in brachial plexus anesthesia. The present study adds evidence specifically for supraclavicular block using xylocaine with adrenaline, demonstrating prolonged analgesia, reduced rescue analgesic use, and good safety. Compared with earlier studies, our work confirms the reproducibility of fentanyl's benefit and highlights its practical value in upper limb surgery. Taken together, the literature suggests that fentanyl is a useful adjuvant when the clinical goal is to extend postoperative pain relief without compromising block safety or hemodynamic stability.

CONCLUSION

The use of fentanyl 50 µg as an adjuvant is simple, cost-effective, and readily implementable in routine clinical practice. The standardized supraclavicular approach with peripheral nerve stimulator guidance ensures reproducible results across different practitioners and settings. This approach offers superior analgesic efficacy, prolonged blockade duration, and reduced postoperative opioid requirements while maintaining an excellent safety profile. Future research should focus on dose-response relationships, comparison with other adjuvants (dexmedetomidine, clonidine, dexamethasone), and long-term outcomes including patient satisfaction and functional recovery. Additionally, studies in specific patient populations (elderly, pediatric, comorbid) would further refine clinical recommendations. In conclusion, fentanyl 50 µg as an adjuvant to xylocaine with adrenaline represents a safe, effective, and clinically superior technique for supraclavicular brachial plexus block in upper limb surgeries, offering significant advantages over xylocaine with adrenaline alone.

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