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Original Research Article

A Clinical Comparison between Dexmedetomidine and Fentanyl as an Adjuvant with Bupivacaine Lignocaine Combination in USG Guided Brachial Plexus Block By Supraclavicular Approach

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Abstract:

Background: Regional anaesthesia technique is mostly preferred for upper limb surgeries due to superior analgesia and reduced systemic complications. The addition of adjuvants to local anaesthetics influences both block characteristics and cardiovascular stability. Dexmedetomidine and fentanyl are commonly used adjuvants; however, comparative evidence remains limited.

Objective: To compare the onset & duration of sensory and motor block, hemodynamic effects and analgesic efficacy of dexmedetomidine versus fentanyl when used as adjuvants to a bupivacaine–lignocaine combination in ultrasound-guided supraclavicular brachial plexus block.

Materials and Methods: A Prospective randomized comparative study including 105 patients (ASA I–II) undergoing unilateral upper limb surgeries below the shoulder were randomly allocated into three groups (n=35 each): Inj. Bupivacaine–lignocaine (Group A), Inj. Bupivacaine–lignocaine with dexmedetomidine 1 µg/kg (Group B), and Inj. Bupivacaine–lignocaine with fentanyl 1 µg/kg (Group C) ; Onset and duration of sensory and motor block, duration of postoperative analgesia and adverse effects were recorded.

Results: Dexmedetomidine significantly reduced onset time and prolonged duration of sensory and motor blockade compared to Group A and Group C. Similarly, it demonstrated significantly lower heart rate and blood pressure compared to Groups A and C ($p<0.05$), without clinically significant hypotension. Duration of analgesia was significantly prolonged in Group B compared to Group C and Group A ($p<0.001$). Mild bradycardia was observed in the dexmedetomidine group but required no intervention.

Conclusion: Dexmedetomidine provides superior hemodynamic stability and prolonged postoperative analgesia compared to fentanyl when used as an adjuvant in supraclavicular brachial plexus block.

Keywords: Dexmedetomidine; Fentanyl; Hemodynamics; Regional Anaesthesia; Cardiovascular Stability.

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Introduction

Regional anaesthesia has become an integral component of modern anaesthetic practice, especially for upper limb surgeries, due to its ability to provide excellent analgesia while maintaining cardiovascular stability. Ultrasound-guided supraclavicular brachial plexus block is widely used as it offers rapid onset, dense sensory blockade, and improved safety compared with landmark-based techniques.

Hemodynamic stability perioperatively provides better outcomes. Alterations in heart rate and blood pressure may lead to adverse cardiovascular outcomes, especially in susceptible patients. Therefore, anesthetic techniques that minimize sympathetic stimulation while ensuring effective analgesia are desirable.

Local anaesthetics such as bupivacaine and lignocaine are routinely used for brachial plexus blocks. However, their duration of action may be insufficient for prolonged surgeries or postoperative analgesia. To overcome this limitation, various adjuvants have been studied to enhance block quality and prolong analgesia.

Dexmedetomidine, a selective α_2-adrenergic agonist, produces analgesia, sedation, and sympatholysis with minimal respiratory depression. Its cardiovascular effects include controlled

reduction in heart rate and blood pressure due to decreased sympathetic outflow. Fentanyl, a potent opioid agonist, is also commonly used as an adjuvant, providing analgesia but with less predictable effects on hemodynamics.

Although both agents are effective adjuvants, comparative data focusing on their efficacy for onset and duration of sensory and motor block, cardiovascular effects during supraclavicular brachial plexus block remain limited. This study was therefore designed to compare the hemodynamic profile and analgesic efficacy of dexmedetomidine and fentanyl when used as adjuvants to a bupivacaine–lignocaine combination.

Materials and Methods

This prospective randomized comparative study was conducted after obtaining approval from the institutional ethics committee. Written informed consent was obtained from all participants.

Study Population: A total of 105 adult patients belonging to either gender, aged 18–65 years, classified as ASA physical status I or II, scheduled for elective unilateral upper limb surgery were enrolled.

Patients with cardiovascular disease, uncontrolled hypertension, arrhythmias, respiratory insufficiency, hepatic or renal dysfunction, coagulopathy, infection at block site, allergy to study drugs, or refusal to participate were excluded.

Randomization and Group Allocation: Patients were randomly allocated into three equal groups (n=35 each):

- **Group A:** Bupivacaine 0.5% + Lignocaine 2%
- **Group B:** Bupivacaine + Lignocaine + Dexmedetomidine 1 µg/kg
- **Group C:** Bupivacaine + Lignocaine + Fentanyl 1 µg/kg

Anesthetic Technique: After premedication with Inj. Midazolam 0.5mg/kg standard ASA monitors were attached to the patient and monitored throughout the procedure. All blocks were performed under ultrasound guidance using a standardized supraclavicular approach. The ultrasound probe was placed over the supraclavicular fossa obtained the best image of the subclavian artery, brachial plexus, and first rib. After injecting a small amount of 1% lidocaine to anesthetise the skin, short bevel needle inserted along the longitudinal axis of the ultrasound probe (in-plane needle approach) drug was administered according to the group. Sensory block onset was defined as the time interval between the end of injection and sensory blockade evidenced by loss of cold sensation using an alcohol swab. Motor block onset was defined as the time interval between the end of injection until achieving a reduction in motor power to grade 3 or less. Motor block duration was defined as the time interval between the end of injection and complete recovery of motor function to grade 1. Sensory block was confirmed by loss to cold sensation using an alcohol swab in all dermatomes. Motor blockade was evaluated by the ability to flex the elbow and hand against gravity as follows: grade 1 = ability to flex and extend the forearm; grade 2 = ability to flex or extend only the wrist and fingers; grade 3 = ability to flex or extend only the fingers; and grade 4 = inability to move the forearm, wrist, and fingers. The block was considered incomplete when any of the dermatome did not have analgesia even after 30 minutes of drug injection. When more than 1 nerve remained unaffected, it was considered a failed block. In such case general anaesthesia was given. Patients who required general anaesthesia or supplemental analgesia were excluded from the study.

Outcome Measures: Primary outcome was onset and duration of sensory and motor block, hemodynamic stability assessed by heart rate, systolic blood pressure, and diastolic blood pressure. Secondary outcomes included and duration of postoperative analgesia.

Statistical Analysis: Data were analyzed using SPSS 17.0. software. Continuous variables were expressed as mean ± standard deviation and compared using ANOVA. Categorical variables were analyzed using Chi-square test. A p-value <0.05 was considered statistically significant.

Results

Demographic variables and baseline hemodynamic parameters were comparable among the three groups.

The onset of sensory and motor block was faster in both adjuvant groups compared to Group A. Duration of sensory and motor blockade was longest in Group B , followed by Group C, and shortest in Group A. Our study proved that addition of dexmedetomidine to bupivacaine and lignocaine for supraclavicular brachial plexus block shortens the onset time and prolongs the duration of motor blockade as compared to the addition of fentanyl.

Duration of postoperative analgesia was significantly prolonged in Group B compared to Group C and Group A ($p<0.001$) and clinically significant. Mild bradycardia occurred in a small number of patients in Group B but did not require pharmacological intervention. No severe adverse cardiovascular events were observed.

Heart rate values were significantly lower in Group B at multiple intraoperative time points compared to Groups A and C ($p<0.05$). Systolic and diastolic blood pressure also showed a greater reduction in Group B; however, values remained within clinically acceptable limits. Mean respiratory rate

did not vary significantly across all groups at all points of time. All patients were monitored for complications during the intra-operative period and up to 24 hours post-operatively. No complications or significant adverse effects were observed in all the study groups

Table 1: Demographic and Baseline Characteristics of Study Groups

Parameter	Group A (BL)	Group B (BL + Dex)	Group C(BL + Fen)	p value
Age (years)	32.4 ± 10.5	39.7 ± 13.2	33.1 ± 14.1	0.033
Sex (M/F)	21 / 14	20 / 15	22 / 13	0.87
Weight (kg)	67.7 ± 9.5	67.1 ± 10.3	66.3 ± 9.8	0.82
Height (m)	1.64 ± 0.07	1.69 ± 0.06	1.61 ± 0.07	<0.001
ASA I / II	26 / 9	28 / 7	27 / 8	0.80

Values expressed as mean ± SD or number.

Table 2: Comparison of Sensory and Motor Block Characteristics

Parameter	Group A	Group B	Group C	p value
Onset of sensory block (min)	18.6 ± 3.4	11.2 ± 2.1	14.8 ± 2.9	<0.001
Onset of motor block (min)	22.4 ± 3.8	14.3 ± 2.5	18.1 ± 3.1	<0.001
Duration of sensory block (min)	410 ± 78	690 ± 95	520 ± 88	<0.001
Duration of motor block (min)	360 ± 65	610 ± 90	470 ± 75	<0.001

Table 3: Duration of Analgesia

Parameter	Group A	Group B	Group C	p value
Time to first rescue analgesia (min)	420 ± 80	820 ± 110	610 ± 95	<0.001
Duration of effective analgesia (min)	390 ± 75	780 ± 105	580 ± 90	<0.001

Table 4: Hemodynamic Parameters (Intraoperative Mean Values)

Parameter	Group A	Group B	Group C	p value
Mean Heart Rate (beats/min)	74.2 ± 6.1	69.8 ± 5.9	72.1 ± 6.4	<0.05
Mean SBP (mmHg)	118.6 ± 12.3	109.4 ± 10.1	113.2 ± 11.5	<0.05
Mean DBP (mmHg)	72.8 ± 8.5	66.9 ± 7.8	70.4 ± 8.1	<0.05

Discussion

When local anaesthesics are used solely, they have a shorter duration of action. The duration of analgesia with local anaesthesics alone can be prolonged with the use of indwelling catheters, but misplacement, migration and infection are the inherent problems with catheter placement. Adjuvants when added to local anaesthesics provide rapid onset of action and prolong the duration of action without the need of an additional procedure and risks of catheter insertion.

Our study demonstrates the use of adjuvants like Dexmedetomidine which is a potent α2-adrenoceptor agonist which exerts its analgesic effect by several hypothesized mechanisms of actions. Some of these include vasoconstriction around the injection site, direct suppression of impulse propagation through neurons, a decrease in localized inflammatory mediators and an increase in anti-inflammatory cytokines through an a2-adrenoceptor-mediated mechanism. When combined with local anaesthetics, dexmedetomidine has the sympatholytic action which contributes to controlled reductions in heart rate and blood pressure, thereby enhancing cardiovascular stability which makes it superior to other adjuvants and also been shown to lengthen the duration of block providing post-operative analgesia.

Fentanyl is a potent synthetic opioid analgesic with a strong agonistic action at the μ opioid receptors with a rapid onset and short duration of action. when added to local anaesthesics in peripheral nerve blocks, potentiates the local anaesthesic action via central opioid receptor-mediated analgesia by acting directly on primary afferent tissues (dorsal horns) which have been found to contain opioid binding sites.

Pain scores were assessed using the Numeric Rating Scale (NRS) from 0 (no pain) to 10 (worst pain). Duration of complete analgesia was defined as the time interval from injection of local anaesthetics administration until the patient had experienced no pain (NRS=0). Duration of effective analgesia was defined as time interval from injection of local anaesthetics administration until there is no need of rescue analgesia (NRS

Fentanyl, while effective in improving analgesia, did not provide comparable autonomic modulation. The mild bradycardia observed with dexmedetomidine aligns with previous studies and was clinically insignificant.

These findings support the use of dexmedetomidine as a preferred adjuvant, particularly in patients where perioperative cardiovascular stability is essential.

Conclusion

Dexmedetomidine is a superior adjuvant to fentanyl when used for supraclavicular brachial plexus block along with bupivacaine and lignocaine, offering enhanced postoperative analgesia and better hemodynamic control without significant adverse effects. Its use may be especially beneficial in patients requiring stable cardiovascular parameters during regional anaesthesia.

The use of ultrasound guided brachial plexus block reduces the risk of complications such as interneural injury, pneumothorax and intravascular injection. The addition of adjuvants to local anaesthetics produces rapid onset, prolong duration of action and also reduced the requirement of analgesic doses. We have limited the dose of dexmedetomidine to maximum 60µg in our study to prevent adverse hemodynamic effects such as hypotension, bradycardia, fainting and sedation.

Limitations: No assessment of sedation level was done in our study after giving sedative drugs. It can be done by Ramsay Sedation Scale. There may be some disparity if we do assessment of the pain by other pain scale such as Visual Analogue Scale (VAS). Age was found to be a confounding factor. Taking large sample size may prevent this.

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