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# COMPARATIVE STUDY BETWEEN DEXMEDETOMIDINE AND FENTANYL AS ADJUVANT TO BUPIVACAINE IN SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK

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**Abstract**

**Background:** This study was conducted to evaluate the effects of fentanyl and dexmedetomidine as adjuvants to bupivacaine used for supraclavicular brachial plexus block in terms of analgesia, duration of motor block, and sensory and motor block onset times.

**Methods:** This was a hospital-based prospective comparative study conducted among 70 patients aged 18-60 years belonging to ASA 1 or 2 undergoing upper limb orthopaedic surgeries under supraclavicular brachial plexus block at the Department of Anesthesiology, Government Medical College, Thrissur, Kerala, India, from January 2021 to December 2022 after obtaining clearance from the institutional ethics committee and written informed consent from the study participants.

**Results:** The statistically significant times for the onset of sensory block were 6.43 ± 1.22 min for the dexmedetomidine group and 10.3 ± 1.25 min for the fentanyl group. The statistically significant motor block onset times were 9.7 ± 0.95 minutes for the dexmedetomidine group and 12.93 ± 1.82 minutes for the fentanyl group. A statistically significant duration of motor block was seen in the dexmedetomidine group (528 ± 48.02 min) and the fentanyl group (460 ± 34.74 min). The duration of sensory block was 538.67 ± 48.62 min in the dexmedetomidine group and 487.33 ± 48.28 min in the fentanyl group, which was statistically significant. The duration of analgesia was 734 ± 34.40 min in the dexmedetomidine group and 650 ± 23.38 min in the fentanyl group, which was statistically significant.

**Conclusion:** Addition of dexmedetomidine to 0.5% bupivacaine in supraclavicular brachial plexus block significantly reduces the onset of sensory and motor block and prolongs the duration of sensory and motor block and the duration of analgesia compared to fentanyl with 0.5% bupivacaine.

**Keywords:** Supraclavicular Brachial Plexus Block, Bupivacaine, Dexmedetomidine, Fentanyl.

## INTRODUCTION

Peripheral nerve blockade has several benefits, including avoiding the side effects of anaesthetics used during general anaesthesia, helping patients with a variety of cardiorespiratory comorbidities, lowering the risk of pulmonary and thromboembolic complications, and lowering the use of opioids.[1] in addition to less discomfort, a quicker discharge timeline, and an improved quality of life during the first few days following surgery. The growing use of regional anaesthesia has led to technological and equipment advancements. From employing paresthesia to localise nerves, the technique has progressed to electrical nerve stimulation and, more recently, ultrasonography.

In order to produce a block with a quick onset, the supraclavicular technique blocks the plexus where it is most compactly organised, at the level of the nerve trunks. The improved quality of anaesthesia results from the brachial plexus's trunks and divisions passing relatively close together when they cross the first rib. At this location, the brachial plexus is in close proximity to the chest cavity and pleura, which is a major concern while giving block. However, using ultrasound (US) guidance to evaluate the plexus, ribs, pleura, and subclavian artery improves safety by enabling better anatomical surveillance and needle placement.[2]

Many local anaesthetics have been used to produce brachial plexus block. The most common among them being bupivacaine, because of its higher potency and prolonged duration of action. Local anesthetics generally block the generation of an action potential in nerve cells by increasing the threshold for electrical excitation. The progression of anesthesia is dependent on factors such as the diameter, degree of myelination, and conduction velocity of the nerve fiber. The length of time a local anaesthetic lasts is correlated with its solubility in lipids. This is because the medication has a higher affinity for lipid membranes and is consequently closer to its areas of action. The drug's effect on the membrane's Na+ channel lasts longer the longer it is present in the region of the membrane as opposed to being absorbed.

To extend the duration of block and postoperative analgesia, a variety of adjuvants have been added to local anaesthetics, including opioids, midazolam, magnesium sulphate, dexamethasone, neostigmine, and clonidine. In intensive care units, patients who are intubated and on mechanical ventilation are given intravenous (IV) sedation and analgesia with dexmedetomidine, an α2 receptor agonist.[3] Peripheral nerve blocks have been reported to utilise it recently. It is around eight times more powerful than clonidine, has a quick onset time, is said to extend the duration of local anaesthetics, and is safe and effective for peripheral nerve blocks.[4]

The analgesic effect is mediated through stimulation of the $\alpha_{2C}$ and $\alpha_{2A}$ receptors in the dorsal horn, which directly suppresses pain transmission by reducing the release of pronociceptive transmitters, substance P and glutamate, and hyperpolarization of interneurons. It is commonly recognised that opioids have analgesic properties at the spinal cord and brain levels. On the other hand, peripheral opioid receptor activation can start an opioid analgesic response.[5]

To increase the length and quality of regional nerve plexus blocks, opioids like fentanyl have been used. Opioids administered peripherally produce a more potent and prolonged analgesic without producing central side effects.

Therefore, improving analgesia by targeting peripheral receptors can prevent crippling centrally mediated side effects such as respiratory depression, altered consciousness, and addiction. Research has indicated that the inclusion of fentanyl improves the success rate and block duration of brachial plexus block. Fentanyl, a synthetic opioid agonist, is more potent and has a quicker beginning of effect than morphine, the naturally occurring parent opioid.

Fentanyl causes superior intraoperative and postoperative analgesia when administered intrathecally without causing hemodynamic instability. When compared to other opioids, the medication's superior safety profile has made it a popular option.[6] The duration of sensory and motor blockade is extended when local anaesthetics are administered in conjunction with dexmedetomidine or fentanyl in neuraxial and peripheral nerve blocks, according to several clinical investigations.

**Aims and Objectives**

To compare the impact of dexmedetomidine and fentanyl as adjuvants to bupivacaine used for supraclavicular brachial plexus block with regard to onset time of sensory block, onset time of motor block, duration of sensory block, duration of motor block and duration of analgesia.

## METHODS

This was a hospital-based prospective comparative study conducted among 70 patients aged 18-60 years belonging to ASA 1 or 2 undergoing upper limb orthopaedic surgeries under supraclavicular brachial plexus block at the Department of Anesthesiology, Government Medical College, Thrissur, Kerala, India, from January 2021 to December 2022 after obtaining clearance from the institutional ethics committee and written informed consent from the study participants.

**Study Procedure**

A total of 70 patients belonging to ASAPS (American Society of Anesthesiologists Physical Status) classes I and II, aged 18–60 years, underwent upper limb, orthopaedic and plastic surgeries under supraclavicular brachial plexus block.

**Sample Size Calculation**

Sample size (n) was calculated by the formula.

$n = (Z\alpha+Z\beta)2\ (S12+S22)$

$d2$

Where,

$Z\alpha$: 1.96 (significant level $\alpha$)

$Z\beta$: 0.84 (significant level $\beta$)

S1: 37.2(standard deviation of dexmedetomidine group)

S2: 36.8 (standard of fentanyl group)

d: 26.3 (mean difference )

As per the statistical calculation the minimum sample size was 31 in each group.

Total sample size: 70

Sample size is calculated for 5% type 1 error (p-value <0.05) and 80% power of study. Values are selected from a previous study by Hamed et al.[4] at Fayoum University, published in Anaesthesia Essays and Researches, April 2018.

**Inclusion Criteria**

Age 18–60 yrs., weight 50–85, ASA classes 1 and 2 for upper limb surgeries not exceeding 2 hours as orthopaedic and plastic surgeries

**Exclusion Criteria**

1. Local infection at the site of the puncture
2. Patient with a neurological defect in the upper limb
3. Patient having hematological disorders, including coagulation abnormality
4. Patients with severe hepatic impairment
5. Known case of allergy to study drug or adjuvant

**Statistical Methods**

Mann-Whitney U test and independent sample T tests have been selected and conducted based on the distribution of the data to find out any statistically significant differences in onset of sensory block, onset of motor block, duration of sensory block, duration of motor block and duration of analgesia between the two drug groups and the results revealed that there were statistically highly significant differences in all the variables between the drug groups as p-values were <0.005.

## RESULTS

| Variables | DRUG. Group A | | DRUG. Group B | | P-Value |
|---|---|---|---|---|---|
| | Mean | S.D | Mean | S.D | |
| Onset of Sensory Block (minutes) | 6.43 | 1.22 | 10.03 | 1.25 | *<0.001 |
| ***Comparison of Onset of Sensory Block in Each Group*** | | | | | |
| **Variables** | **DRUG. Group A** | | **DRUG. Group B** | | **P-Value** |
| | **Mean** | **S.D** | **Mean** | **S.D** | |
| Onset of Motor Block (minutes) | 9.7 | 0.95 | 12.93 | 1.82 | *<0.001 |
| ***Comparison of Onset of Motor Block in Each Group*** | | | | | |
| ***Table 1*** | | | | | |

Group B observed a mean onset time of 10.03 ± 1.25 min, with a p-value of < 0.001, while group A experienced a quicker 6.43 ± 1.22 min.
Hence, the two groups were statistically significant.
Group A had a faster mean time to motor block onset of 9.7 ± 0.95 min, whereas group B had a mean time of 12.93 ± 1.82 min, with a p-value of < 0.001. Therefore, there was a statistically significant difference.

| Variables | DRUG. Group A | | DRUG. Group B | | P-Value |
|---|---|---|---|---|---|
| | Mean | S.D | Mean | S.D | |
| Duration of Sensory Block (minutes) | 538.67 | 48.6 | 487.33 | 48.28 | *0.001 |
| ***Comparison of Duration of Sensory Block in Each Group)*** | | | | | |
| **Variables** | **DRUG. Group A** | | **DRUG. Group B** | | **P-Value** |
| | **Mean** | **S.D** | **Mean** | **S.D** | |
| Duration of Motor Block (minutes) | 528 | 48.02 | 460 | 34.74 | *<0.001 |
| ***Comparison of Duration of Motor Block in Each Group*** | | | | | |
| ***Table 2*** | | | | | |

Group A had a longer mean time of sensory block (538.67 ± 48.6 min), whereas group B had a shorter mean duration of 487.33 ± 48.28 min (p < 0.001). Hence, the difference was statistically significant.
The mean duration of motor block in group A was 528 ± 48.02 min, which was longer and group B was 460 ± 34.74 min, which was found to be shorter with a p-value of < 0.001. Hence, the difference was statistically significant.

| Variables | DRUG. Group A | | DRUG. Group A | | P-Value |
|---|---|---|---|---|---|
| | Mean | S.D | Mean | S.D | |
| Duration of Analgesia (minutes) | 734 | 34.40 | 650 | 23.34 | *<0.001 |
| ***Table 3: Comparison of Duration of Analgesia in Each Group (minutes)*** | | | | | |

The mean duration of analgesia in group A was 734 ± 34.4 min, which was longer and group B was 650 ± 23.34 min, which was found to be shorter with a p-value of < 0.001. Hence, the difference was statistically significant.

## DISCUSSION

At Government Medical College in Thrissur, 70 patients had upper limb orthopaedic procedures under supraclavicular brachial plexus block. Patients were divided into two groups: Group A underwent supraclavicular brachial plexus block with 0.5% bupivacaine 20 ml and 1 mcg/kg of dexmedetomidine, whereas Group B received the same treatment but with 0.5% bupivacaine 20 ml and 1 mcg/kg of fentanyl. The purpose of the study was to compare the effectiveness of fentanyl against dexmedetomidine as a brachial plexus block adjuvant to bupivacaine.

The demographic information for Groups A and B was similar. Within the study group, the average age was 36.82 ± 12.18. The mean height among the study group was 166.26 ± 7.88. The mean weight was 65.27 ± 8.17.

40% of the study group consisted of females and 60% of males. The distribution of ASA PS classes 1 and 2 among the study group was 55% and 45% respectively.

Sensory blocks were compared between the two groups. Onset of sensory block was 6.43 ± 1.1.22 min in group A and 10.03 ± 1.25 min in group B. the p-value was < 0.001 and the result was statistically significant.

The length of the sensory block was 487.33 ± 48.28 minutes for group B and 538.67 ± 48.62 minutes for group A. The p-value was less than 0.001, indicating the statistical significance of the outcome.

The onset of the motor block was 9.7 ± 0.97 min in group A and 12.93 ± 1.82 min in group B. The p-value was < 0.001, and the result was statistically significant.

In group A, the motor block lasted 528 ± 48.02 minutes, while in group B, it lasted 460 ± 34.74 minutes. The p-value was less than 0.001, indicating the statistical significance of the outcome.

In group A, analgesia lasted 734 ± 34.4 minutes, while in group B, it lasted 650 ± 23.34 minutes. The outcome was statistically significant, with a p-value of less than 0.001. Renuka Holyachi *et al.* in 2017[7] conducted a comparative study between dexmedetomidine and fentanyl as adjuvants to ropivacaine. Eighty patients who were scheduled for elective upper limb procedures and had American Society of Anesthesiologists grade I/II status were divided into two groups at random. Patients in group A were given 30 mL of 0.5% ropivacaine mixed with 1 μg kg−1 dexmedetomidine for a supraclavicular brachial block guided by USG. Patients in group B were given 30 mL of 0.5% ropivacaine mixed with 1 μg kg−1 fentanyl. Notable were the beginning and length of the sensory and motor block, the need for rescue analgesia, and any unfavourable events that occurred during the perioperative phase.

They discovered that the dexmedetomidine group had sensory blocking at 13.95 ± 1.34 minutes, whereas the fentanyl group experienced it at 14.18 ± 1.41 minutes. Regarding the length of the sensory blockage, there was a statistically significant difference (p<0.0001): 801.75 ± 46.07 min with dexmedetomidine versus 590.25 ± 40.41 min with fentanyl. Compared to group B, which experienced motor blockage for 456.75 ± 32.93 minutes, group A experienced it for 649.56 ± 42.73 minutes, a very statistically significant difference.

They found that when added to ropivacaine in supraclavicular brachial plexus block, dexmedetomidine makes the sensory and motor block last longer than fentanyl and doesn't cause any major side effects. Furthermore, it provides better pain relief after surgery. The results were comparable to our study.

Swastika Swaro et al., Daisy Kurian et al., and Swarna Nanerjee et al. on a comparative study between dexmedetomidine and fentanyl as adjuvants to bupivacaine in supraclavicular brachial plexus block: a randomized double blind prospective study.

In a randomised, double-blinded procedure, fifty Physical Status I and II patients, according to the American Society of Anesthesiologists were scheduled for elective upper limb procedures under supraclavicular brachial plexus block. The patients were split into two equal groups. Patients in groups BF and BD were given 30 millilitres of bupivacaine mixed with 50 Î¼g of fentanyl and 50 Î¼g of dexmedetomidine, respectively. Both groups' anaesthesia and analgesia characteristics were evaluated.

They discovered that the length of the motor and sensory blocks was 441.52 ± 48.46 minutes and 452.96 ± 77.12 minutes in Group BD, respectively, whereas it was 363.4Â ± 38.36 minutes and 357Â ± 36.77 minutes in Group BF. Between the two groups, there was a statistically significant difference in the start of sensory and motor blocks. Group BD experienced a longer duration of analgesia (time to require rescue analgesia) (471.44 ± 65.88 minutes vs. 366.48 ± 38.02 minutes) with statistical significance (p < 0.0001). With the exception of a grade 3 sedation score that was higher in group BD, there were very few hemodynamic disruptions and adverse effects in either group.

They came to the conclusion that adding dexmedetomidine to bupivacaine in supraclavicular brachial plexus block prolonged both the duration of analgesia and the sensory and motor block more than adding fentanyl. In our study, we also observed similar findings.

In upper extremity orthopaedic surgery, Sane et al evaluated the impact of dexmedetomidine with bupivacaine vs. bupivacaine alone on sensory and motor block duration, pain score, and hemodynamic fluctuations in the supraclavicular block. Sixty individuals, ages 20 to 60, participated in the study.

Patients in the dexmedetomidine group (intervention group) received 39 ml of bupivacaine (0.25%) + 0.75 $\mu$g/kg dexmedetomidine (total volume 40 ml). Patients in the control group received 39 ml of 0.25% bupivacaine + 1 ml of normal saline (total volume 40 ml). In patients receiving just bupivacaine, the mean start time of sensory and motor block was $31.03 \pm 9.65$ min and $24.66 \pm 9.2$ min, respectively. In the group receiving dexmedetomidine, the mean onset times were around $21.36 \pm 8.34$ min and $15.93 \pm 6.36$ minutes. Both groups saw comparable changes in mean arterial blood pressure and heart rate. In the intervention group, sensory and motor block durations, as well as the initial analgesia request time, were greater. For a whole day, the intervention group experienced less postoperative discomfort.

They came to the conclusion that bupivacaine and dexmedetomidine lengthened the period of numbness and immobility and slowed the development of sensory and motor blocks. Dexmedetomidine also considerably decreased postoperative pain when supraclavicular blocks were performed with bupivacaine.

Mohamed Ahmed Hamed et al.[4] at Fayoum University Hospital, about the comparison between dexmedetomidine and fentanyl as adjuvants to 0.5% bupivacaine in a prospective randomised controlled double-blinded clinical study.

Sixty patients, between 18 and 50 years old, who were scheduled for upper limb surgery and had physical status classes I and II on the American Society of Anesthesiologists were randomly assigned to three research groups, each with twenty patients: C Group: up to a 40 mL volume limit, get 0.5 mL/kg. The bupivacaine dosage was 1.5 mg/kg. D Group: 1 mcg/kg of dexmedetomidine plus bupivacaine as the control group. F Group: 1 mcg/kg of fentanyl plus bupivacaine as the control group. Patients were monitored for side effects, postoperative pain, duration of analgesia, and onset and duration of sensory and motor blockage.

They discovered that in the D group ($p < 0.001$) and F group ($p < 0.001$), the duration of the block was considerably prolonged and the start time of sensory and motor blockade was decreased. Additionally, the D group's postoperative analgesia lasted 13.5 hours longer than that of the F group (8.3 hours) and the C group (7.5 hours). Two patients in the D group experienced bradycardia and hypotension, whereas the F group experienced vomiting and nausea.

With an α2:α1 binding selectivity ratio of 1620:1, which is lower than clonidine's 220:1 ratio, dexmedetomidine, the pharmacologically active d-isomer of medetomidine, is a highly selective and specific α2 adrenoceptor agonist that reduces the undesirable side effects of α1 receptors. The central nervous system (CNS) releases less norepinephrine when α2 adrenoceptors are postsynaptically activated, which stops the transmission of pain signals. This also reduces heart rate and blood pressure (HR and BP).[8]

## CONCLUSION

Based on the onset and duration of sensory block, motor block, and duration of analgesia, we examined the effects of adding dexmedetomidine vs. fentanyl as adjuvants to 0.5% Bupivacaine in supraclavicular brachial plexus block for upper limb orthopaedic procedures. The study concludes that, in comparison to 1 mcg/kg of fentanyl, the addition of 1 mcg/kg of dexmedetomidine to 0.5% Bupivacaine greatly reduces the onset of sensory and motor block, as well as lengthens the duration of both.

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