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Comparative Study Between Dexmedetomidine and Fentanyl as Adjuvant to Ropivacaine in Supraclavicular Brachial Plexus Block

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Abstract

Background: The research aimed to assess how fentanyl and dexmedetomidine impact Ropivacaine in supraclavicular brachial plexus blocks regarding pain relief, motor block duration, and onset times for sensory and motor blocks.

Methods: This prospective comparative study involved 70 patients (aged 18-60, ASA 1 or 2) undergoing upper limb orthopaedic surgeries at the Department of Anesthesiology, Dr. M.K. Shah Medical College, Ahmedabad, Gujarat, India. It was conducted from January 2023 to December 2023 after participant consent.

Results: Significant differences were observed in sensory block onset times: 6.42 ± 1.21 min for dexmedetomidine vs. 10.04 ± 1.24 min for fentanyl. Motor block onset times were also significant: 9.8 ± 0.96 min (dexmedetomidine) vs. 12.90 ± 1.80 min (fentanyl). Duration of motor block was longer with dexmedetomidine (527 ± 48.01 min) than fentanyl (459 ± 34.73 min). Sensory block duration was also longer with dexmedetomidine (538.66 ± 48.5 min) compared to fentanyl (487.32 ± 48.27 min). Dexmedetomidine provided prolonged analgesia (734.1 ± 34.30 min) compared to fentanyl (650.1 ± 23.33 min).

Conclusion: The addition of dexmedetomidine to 0.5% Ropivacaine in supraclavicular brachial plexus block significantly hastens the onset of sensory and motor blocks, prolongs their duration, and extends analgesia compared to fentanyl combined with 0.5% Ropivacaine.

Keywords: Ropivacaine, Fentanyl, Supraclavicular Brachial Plexus Block, Dexmedetomidine.

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INTRODUCTION

There are additional benefits to peripheral nerve blockade, such as avoiding the adverse effects of general anesthesia drugs, facilitating patients with numerous comorbidities in the cardiorespiratory range, and diminishing pulmonary and prothrombotic complications and the consumption of opioids.[1] From the application of paraesthesia for nerve localization, the technique was expanded to electrical nerve stimulation and more recently ultrasonography.

Finally, the supraclavicular technique can be used to produce a block with a quick onset, as the plexus is blocked where it is most compactly organised at the level of the nerve trunks. The quality of anaesthesia is improved because the brachial plexus's trunks and divisions are relatively close together as they cross the first rib. The brachial plexus is located near to the chest cavity and pleural cavity at this point, which is the most significant disadvantage while providing the block.[2]

Ropivacaine is a commonly used local anaesthetic for inducing brachial plexus block due to its potency and prolonged action duration. It hinders nerve cell action potential generation and its duration is influenced by factors like nerve fibre diameter, myelination, and conduction velocity. The drug's impact on the Na+ channel persists longer when near the membrane.

Adjuvants like opioids, midazolam, magnesium sulphate, dexamethasone, neostigmine, and clonidine are combined with local anaesthetics to prolong block and postoperative analgesia duration. Dexmedetomidine, an α2 receptor agonist, is used for peripheral nerve blocks, which is eight times more potent than clonidine.[3,4] The analgesic effect is achieved by stimulating α2C and α2A receptors in the dorsal horn, suppressing pain transmission.[5] Fentanyl, a synthetic opioid agonist, is used to enhance the success rate and block duration of brachial plexus blocks without causing central side effects.[6]

AIMS AND OBJECTIVES

The aim of this study is to compare the effects of dexmedetomidine and fentanyl when used as adjuvants to Ropivacaine in supraclavicular brachial plexus block. Specifically, we will compare the onset time of sensory block, onset time of motor block, duration of sensory block, duration of motor block, and duration of analgesia.

METHODS

This study was conducted at the Department of Anaesthesiology, Dr, M.K. Shah Medical College, Ahmedabad, Gujarat, India. It was a hospital based prospective comparative study involving 70 patients aged 18-60 years who were classified as ASA 1 or 2 and were undergoing upper limb orthopaedic surgeries under supraclavicular brachial plexus block. The study was conducted from January 2023 to December 2023, after obtaining all the necessary approval and written informed consent from the study participants.

Supraclavicular brachial plexus block was given with the patient placed in supine position with head turned to opposite side. The probe of the ultrasound was placed in the supraclavicular fossa and brachial plexus was identified.

Patients were divided into two groups: Group A underwent supraclavicular brachial plexus block with 0.5% Ropivacaine 20 ml and 1 mcg/kg of dexmedetomidine, whereas Group B received the same treatment but with 0.5% Ropivacaine 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 Ropivacaine.

Sample Size

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 orthopedic 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 haematological 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 as p-values were <0.005.

RESULT

In our study, our observations showed that the hemodynamic parameters like Heart Rate, Blood Pressure and Spo2 were in optimal range in both groups. Respiratory parameters were almost similar in both study group.

	Group A		Group B		P value
	Mean	SD	Mean	SD	
Onset of sensory block (min)	6.42	1.21	10.04	1.24	<0.001
Onset of motor block (min)	9.8	0.96	12.90	1.80	<0.001

Group B observed a mean onset time of 10.04 ± 1.24 min, with a p-value of < 0.001, while group A experienced a quicker 6.42 ± 1.21 min. Hence, the two groups were statistically significant. Group A had a faster mean time to motor block onset of 9.8 ± 0.96 min, whereas group B had a mean time of 12.90 ± 1.80 min, with a p-value of < 0.001. Therefore, there was a statistically significant difference.

	Group A		Group B		P value
	Mean	SD.	Mean	SD.	
Duration of sensory block (min)	538.66	48.5	487.32	48.27	<0.001
Duration of motor block (min)	527	48.01	459	34.73	<0.001

Group A had a longer mean time of sensory block (538.66 ± 48.5 min), whereas group B had a shorter mean duration of 487.32 ± 48.27 min (p < 0.001). Hence, the difference was statistically significant. The mean duration of motor block in group A was 527 ± 48.01 min, which was longer and group B was 459 ± 34.73 min, which was found to be shorter with a p-value of < 0.001. Hence, the difference was statistically significant.

	Group A		Group B		P value
	Mean	SD	Mean	SD	
Duration of analgesia (min)	734.1	34.3	650.1	23.33	<0.001

The mean duration of analgesia in group A was 734.1 ± 34.3 min, which was longer and group B was 650.1 ± 23.33 min, which was found to be shorter with a p-value of < 0.001. Hence, the difference was statistically significant.

DISCUSSION

At Dr. M.K. Shah Medical College, Ahmedabad, Gujarat, 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% Ropivacaine 20 ml and 1 mcg/kg of dexmedetomidine, whereas Group B received the same treatment but with 0.5% Ropivacaine 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 Ropivacaine.

The demographic characteristics of Groups A and B were comparable. In the study population, the average age was 36.82 ± 12.18 years. The mean height in the study group was 166.26 ± 7.88 cm, while the mean weight was 65.27 ± 8.17 kg.

Females made up 40% of the study group, whereas males accounted for 60%. The distribution of ASA PS classes 1 and 2 in the study group was 55% and 45%, respectively.

Comparisons were made between sensory blocks in the two groups. The onset of sensory block was 6.42 ± 1.21 minutes in group A and 10.04 ± 1.24 minutes in group B, with a p-value of < 0.001, indicating statistical significance.

The duration of the sensory block was 487.32 ± 48.27 minutes for group B and 538.66 ± 48.61 minutes for group A, with a p-value of <0.001, showing statistical significance.

Regarding the motor block, the onset was 9.8 ± 0.96 minutes in group A and 12.90 ± 1.80 minutes in group B, with a p-value of <0.001, indicating statistical significance. The motor block lasted 527 ± 48.01 minutes in group A and 459 ± 34.73 minutes in group B, with a p-value of <0.001, showing statistical significance.

In terms of analgesia, it lasted 734.1 ± 34.3 minutes in group A and 650.1 ± 23.33 minutes in group B, with a p-value of < 0.001, indicating statistical significance.

Dharmarao et al.[7] conducted a comparative study in 2017 between dexmedetomidine and fentanyl as adjuvants to ropivacaine in eighty patients undergoing elective upper limb procedures with ASA grade I/II status. Patients in group A received 30 mL of 0.5% ropivacaine mixed with 1 µg kg−1 dexmedetomidine, while those in group B received 30 mL of 0.5% ropivacaine mixed with 1 µg kg−1 fentanyl. Key outcomes included the onset and duration of sensory and motor blocks, the requirement for rescue analgesia, and others.

The researchers made an interesting discovery during their study. They found that the group of patients who received dexmedetomidine experienced sensory blocking at an average of 13.95 ± 1.34 minutes, while the fentanyl group experienced it slightly later at 14.18 ± 1.41 minutes. This difference in timing was statistically significant (p<0.0001), with the dexmedetomidine group having a longer sensory blockage duration of 801.75 ± 46.07 minutes compared to 590.25 ± 40.41 minutes in the fentanyl group. Additionally, when comparing the motor blockage duration, group A (dexmedetomidine) had a significantly longer duration of 649.56 ± 42.73 minutes compared to group B (fentanyl) with 456.75 ± 32.93 minutes.

The researchers also found that when dexmedetomidine was added to ropivacaine in supraclavicular brachial plexus block, it resulted in a longer duration of both sensory and motor blockage compared to fentanyl. Furthermore, dexmedetomidine did not cause any major side effects and provided better pain relief after surgery.

These results were consistent with previous studies conducted by Swaro et al.[8] In this study, fifty patients with Physical Status I and II, according to the American Society of Anaesthesiologists, were randomly assigned to two groups in a double-blinded procedure. Both groups underwent elective upper limb procedures under supraclavicular brachial plexus block. Group BF received 30 millilitres of bupivacaine mixed with 50 µg of fentanyl, while group BD received the same amount of bupivacaine mixed with 50 µg of dexmedetomidine. The anesthesia and analgesia characteristics of both groups were evaluated.

In Group BD, the length of the motor and sensory blocks was found to be 441.52 ± 48.46 minutes and 452.96 ± 77.12 minutes, respectively. On the other hand, in Group BF, the duration of the motor and sensory blocks was 363.4 ± 38.36 minutes and 357 ± 36.77 minutes, respectively. There was a significant difference in the start of sensory and motor blocks between the two groups. Group BD also had a longer duration of analgesia (471.44 ± 65.88 minutes) compared to Group BF (366.48 ± 38.02 minutes), with statistical significance (p < 0.0001). Apart from a higher grade 3 sedation score in Group BD, both groups experienced minimal hemodynamic disruptions and adverse effects.

In our investigation, we reached the conclusion that the addition of dexmedetomidine to local anaesthetic in supraclavicular brachial plexus block significantly extended the duration of analgesia, sensory and motor block compared to the addition of fentanyl. Similarly, our research yielded similar results.

In a study on upper extremity orthopaedic surgery, Sane et al. examined the effects of dexmedetomidine with bupivacaine versus bupivacaine alone on sensory and motor block duration, pain levels, and hemodynamic variations in supraclavicular block.[9] The study involved sixty participants aged 20 to 60. Patients in the intervention group, who received dexmedetomidine, were administered 39 ml of bupivacaine (0.25%) + 0.75 µg/kg dexmedetomidine (total volume 40 ml). The control group received 39 ml of 0.25% bupivacaine + 1 ml of normal saline (total volume 40 ml). The onset times for sensory and motor blocks in patients receiving only bupivacaine were 31.03 ± 9.65 min and 24.66 ± 9.2 min, respectively. In contrast, the group receiving dexmedetomidine had onset times of approximately 21.36 ± 8.34 min and 15.93 ± 6.36 min. Both groups exhibited similar changes in mean arterial blood pressure and heart rate. The intervention group showed longer durations of

sensory and motor blocks, as well as delayed initial analgesia request time. Throughout the entire day, the intervention group reported less post-operative discomfort.

The researchers concluded that bupivacaine and dexmedetomidine extended the duration of numbness and immobility, as well as slowed down the progression of sensory and motor blocks. Additionally, dexmedetomidine significantly reduced postoperative pain in cases where supraclavicular blocks were carried out with bupivacaine.

In a clinical study conducted by Hamed et al. at Fayoum University Hospital, dexmedetomidine and fentanyl were compared as adjuvants to 0.5% bupivacaine and investigated.[4] Sixty patients, aged between 18 and 50 years old, with ASA physical status classes I and II, scheduled for upper limb surgery, were randomly divided into three groups, each consisting of twenty patients: Group C received up to a 40 mL volume limit, with a dosage of 0.5 mL/kg bupivacaine at 1.5 mg/kg. Group D received 1 mcg/kg of dexmedetomidine in addition to bupivacaine, serving as the control group. Group F received 1 mcg/kg of fentanyl in addition to bupivacaine, also serving as the control group. Patients were closely monitored for side effects, postoperative pain, duration of analgesia, as well as the onset and duration of sensory and motor blockades. In the D group and F group, the duration of the block was significantly prolonged, while the start time of sensory and motor blockade was decreased. Additionally, the effect of analgesia postoperatively in the D group was 13.5 hours greater than in the F group (8.3 hours) and the C group (7.5 hours). Two patients in the D group experienced bradycardia and hypotension, while the F group experienced vomiting and nausea.

Dexmedetomidine, with an α2:α1 binding selectivity ratio of 1620:1, is a highly selective and specific α2 adrenoceptor agonist that reduces the undesirable side effects of α1 receptors compared to clonidine's 220:1 ratio. Activation of α2 adrenoceptors post-synaptically in the central nervous system leads to reduced norepinephrine release, which inhibits pain signal transmission, as well as decreases heart rate and blood pressure.[10]

CONCLUSION

Based on our analysis of the sensory block, motor block, and analgesia duration, we investigated the impact of incorporating dexmedetomidine versus fentanyl as supplementary agents to 0.5% Ropivacaine in supraclavicular brachial plexus block for upper limb orthopaedic procedures. Our findings indicate that the addition of 1 mcg/kg of dexmedetomidine to 0.5% Ropivacaine significantly decreases the onset of sensory and motor block, while also prolonging their duration, when compared to the use of 1 mcg/kg of fentanyl.

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