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ORIGINAL RESEARCH ARTICLE

A Comparative Study between Dexmedetomidine, Clonidine and Fentanyl as Adjuvants to Bupivacaine in Ultrasound Guided Supraclavicular Brachial Plexus Block

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ABSTRACT

Introduction: Supraclavicular brachial block is a popular and widely used nerve block technique for perioperative anesthesia and analgesia for upper extremity surgery. The block is performed at level of distal trunks and the origin of divisions, where the brachial plexus is confined to its smallest surface area, thus producing a rapid and reliable block of the plexus. It is the popular technique of anesthesia for upper limb surgeries due to its effectiveness in terms of performance, cost, margin of safety and good post-operative analgesia. It provides rapid onset, dense upper limb anesthesia with a single injection.

Materials and Methods: About 90 patients who underwent elective upper limb Orthopaedics surgery during the period of the study were randomly divided into three equal groups of participants each using a computer-based random number generator, i.e., group C, D and F. They were compared for the onset and duration of motor and sensory block and post operative analgesia.

Results: Mean onset of sensory and motor block was minimum for fentanyl (7.13 ± 0.94, 9.77 ± 0.82 minutes) followed by dexmedetomidine (7.37 ± 1.06, 11.33 ± 1.61 minutes) and clonidine (8.73 ± 0.98, 12.23 ± 1.57 minutes). Duration of block amongst the three groups showed statistically significant difference, dexmedetomidine (585.13 ± 44.42, 546.07 ± 42.02 minutes) having maximum duration of sensory and motor block followed by clonidine (535.77 ± 32.11, 507.30 ± 33.59 minutes) and minimum for fentanyl (330.03 ± 44.25, 284.67 ± 59.96 minutes).

Conclusion: We concluded that adding fentanyl to bupivacaine for supraclavicular brachial plexus block had a faster onset of sensory and motor blockade when compared to dexmedetomidine and clonidine, and dexmedetomidine prolonged the duration of analgesia when compared with clonidine and fentanyl.

Keywords: Dexmedetomidine, Clonidine, Fentanyl, Bupivacaine, Supraclavicular brachial plexus block.

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INTRODUCTION

The supraclavicular brachial block is a popular and widely used nerve block technique for perioperative anesthesia and analgesia for upper extremity surgery.[1]

The block is performed at level of distal trunks and the origin of divisions, where the brachial plexus is confined to its smallest surface area, thus producing rapid and reliable block of the plexus. It is the popular technique of anesthesia for upper limb surgeries due to its effectiveness in terms of performance, cost, margin of safety and good post-operative analgesia.[2] It provides rapid onset, dense upper limb anesthesia with a single injection.[3]

When using the landmark technique for regional blockade, poor localization of nerves can be due to anatomical variation or trauma to the region, and results in failed block and may cause morbidity. In the upper limb, surface ultrasound can clearly identify neural elements of the brachial plexus as well as surrounding structures.[4-6] Ultrasound-guided brachial plexus block has the advantage of precise nerve localization, real-time visualization of the plexus, blood vessels, needle placement and local anesthetic spread. It minimizes the number of needle attempts. The supraclavicular brachial block is performed using local anesthetics, providing rapid onset of reliable brachial plexus blockade.

Large volumes of local anesthetics required to produce desirable effects may result in systemic side effects. Adjuvants have been added to increase analgesia and reduce the total dose of local anesthetics, minimizing the risk for local anesthetic toxicity. Various drugs are used as adjuvants to alter the block in terms of onset, duration, quality and postoperative analgesia. Bupivacaine is the most frequently used local anesthetic drug due to its prolonged duration of action (4–8 hours). Adjuvants of recent interest include alpha 2 agonists- like clonidine, dexmedetomidine and fentanyl.

Clonidine an α2-adrenergic agonist, has been used as an adjuvant to local anesthetics for regional anesthesia. It has been shown that the addition of clonidine to intermediate and long-acting local anesthetics during single-shot peripheral nerve or nerve plexus block provides a longer duration of analgesia and motor blockade by nearly two hours. Clonidine causes dose-dependent bradycardia, hypotension, and sedation.[7-9] Its use in neuraxial blocks is well-studied.[10,11]

Dexmedetomidine is a dextro-enantiomer and is an active component of medetomidine-approved as an intravenous sedative and co-analgesic drug. Its alpha2/alpha1 selectivity ratio is eight times of clonidine. The addition of dexmedetomidine to local anesthetic during peripheral nerve blockade has been demonstrated to prolong the duration of block and postoperative analgesia.

Fentanyl is a synthetic, lipophilic phenyl piperidine opioid agonist with analgesic and anesthetic properties. It selectively binds and activates the mu-receptor in the central nervous system (CNS), thereby mimicking the effects of endogenous opiates. Fentanyl citrate is the most commonly used opioid in regional anesthesia.

In this study, our objective is to assess the superiority of one adjuvant over another and compare the intraoperative hemodynamic stability post-operative analgesic effect of dexmedetomidine, clonidine and fentanyl when added as adjuvants to bupivacaine in patients undergoing elective upper limb surgeries.

MATERIAL AND METHODS

It is a prospective randomized comparative study of 90 patients who underwent elective upper limb Orthopaedics surgery during the period of the study. A routine pre-anesthetic visit was conducted for all patients after noting each patient's medical history, where a thorough systemic examination was carried out. Routine and special investigations, as required, were carried out accordingly. Prior to participation in the study, during the visit, all patients have explained the purpose of the study, the advantages and risks of the procedure to be performed and possible side effects. Patients were educated sufficiently about the 10 cm visual analogue scale (VAS) during the pre-operative assessment. All patients were instructed to remain nil orally for at least eight hours before surgery.

All patients were randomly divided into three equal groups of participants each using a computer-based random number generator, i.e., group C, group D and group F.

- Group C: Patients receive 15 mL Inj.0.25% bupivacaine + 1 μg/kg clonidine
- Group D: Patients receive 15 mL Inj.0.25% bupivacaine + 1 μg/kg dexmedetomidine.
- Group F: Patients receive 15 mL inj. 0.25% bupivacaine + 1 μg/kg fentanyl

On arrival in the operating room, baseline vitals of the patient's heart rate, NIBP, and oxygen saturation were noted. All the necessary equipment and drugs needed for general anesthesia were kept ready in order to manage a failed block

Technique

- The patient was positioned supine, and the head was turned to the opposite side of the shoulder.
- The skin was disinfected and the transducer was positioned in the transverse plane just proximal to the clavicle, slightly posterior to its midpoint.
- The brachial plexus was identified as a bunch of grapes lateral to the artery.
- The needle was inserted cephalad to the probe in posteriorly.
- The needle tip was advanced deeper towards the deep border of the plexus and the drug was injected after careful aspiration for the blood.

Assessment

Sensory block

It was assessed by pinprick method in all the dermatomes corresponding to radial, ulnar, median and musculocutaneous nerves till complete sensory block was achieved and post-operatively until the resolution of the block. Onset time for the sensory block was defined as ime interval between the end of local anesthetic administration and the sensory block of grade 1 for all the nerves. Duration of sensory block was the time interval between the sensory block grade 1 and till complete resolution of the block on all the nerves, grade 0.

- Grade 0 – sharp pin felt
- Grade 1 – analgesia, dull sensation
- Grade 2 – anesthesia, no sensation felt

Motor block

It was assessed by a modified bromage scale for upper extremity every three minutes till the loss of movements and then every 15 minutes post-operatively until the resolution of block. The onset time for the motor block was the time interval between total local anesthetic administration and motor block (Grade 1). The duration of the motor block was defined as the time interval between block grade 1 and the complete recovery of motor function.

- Grade 0 : normal motor function with full extension of elbow, wrist and fingers.
- Grade 1 : decreased motor strength with ability to move the fingers only.

Table 1: Comparison of sensory onset and duration

Sensory		Group			p-value
		C (minutes)	D (minutes)	F (minutes)	
Onset	Mean ± SD	8.73 ± 0.98	7.37 ± 1.06	7.13 ± 0.94	<0.001
Duration	Mean ± SD	535.77 ± 32.11	585.13 ± 44.42	330.03 ± 44.25	<0.001

Table 2: Comparison of motor onset and duration

Motor		Group			p-value
		C (minutes)	D (minutes)	F (minutes)	
Onset	Mean ± SD	12.23 ± 1.57	11.33 ± 1.61	9.77 ± 0.82	<0.001
Duration	Mean ± SD	507.30 ± 33.59	546.07 ± 42.02	284.67 ± 59.96	<0.001

Table 3: Comparison of time for first rescue analgesia

Time of first rescue analgesia	Group			p-value
	C (minutes)	D (minutes)	F (minutes)	
Mean ± SD	552.73 ± 31.59	612.97 ± 41.13	353.30 ± 44.57	<0.001

- Grade 2: complete motor block with inability to move fingers

Post-operative analgesia

It was assessed with VAS (visual analogue score) from 0 to 10. It was explained pre-operatively to all the patients that, one end of the line depicts '0', which represents no pain at all , while the other end depicts '10', which represents severe pain. Patients were asked to rate the degree of the pain by making a mark on the linear scale. Thus the pain score was obtained. Rescue analgesia was given in the form of inj tramadol 2 mg/kg. Post-operative analgesia was the time interval between the complete sensory block and a numeric rating of more than four on the VAS score, i.e., when the rescue analgesia was given.

At the end of the procedure, the patients were shifted to the recovery room and monitored every 15 minutes for resolution of the blocks and assessment of post-operative pain was done using VAS at 2, 4, 6, 12, 18, 24 hours.

Statistical Analysis

The observations were recorded, tabulated, and subjected to statistical analysis using SPSS software. *p-value* ≤ 0.05 was considered as statistically significant.

RESULTS

All the groups were comparable in the demographic data with respect to age, gender and weight.

The mean onset of sensory (Table 1) and motor (Table 2) block was minimum for fentanyl (7.13 ± 0.94, 9.77 ± 0.82 minutes) followed by dexmedetomidine (7.37 ± 1.06, 11.33 ± 1.61 minutes) and clonidine (8.73 ± 0.98, 12.23 ± 1.57 minutes).

Duration of block amongst the three groups showed statistically significant difference, dexmedetomidine (585.13 ± 44.42, 546.07 ± 42.02 minutes) having maximum duration of sensory and motor block followed by clonidine (535.77 ± 32.11, 507.30 ± 33.59 minutes) and minimum for fentanyl (330.03 ± 44.25, 284.67 ± 59.96 minutes).

The duration of postoperative analgesia (Table 3) was maximum with dexmedetomidine (612.97 ± 41.13 minutes) followed by clonidine (552.73 ± 31.59 minutes) and minimum with fentanyl (353.30 ± 44.57 minutes).

Hemodynamic changes observed were similar in all the groups for all three parameters studied. A comparison of pre-op hemodynamic parameters with the intra-op parameters was done by applying an ANOVA test, as shown in Figures 1, 2, and 3. The pattern of change was also similar. Thus, all three drugs had the same hemodynamic safety profile.

DISCUSSION

Brachial plexus block has been proven to be a better alternative for upper limb surgeries. In upper limb surgeries, ultrasound can clearly identify neural elements of the brachial plexus and visualize the needle in real-time. Nazir *et al.* conducted a randomized controlled trial study in 70 patients to assess the effect of adding dexmedetomidine to bupivacaine for the supraclavicular block. They concluded dexmedetomidine as adjuvant to bupivacaine in supraclavicular block, resulting in faster action, prolonged motor and sensory block, and prolonged analgesia with hemodynamic stability.[12] In our study, we have compared clonidine, dexmedetomidine and fentanyl as adjuvants to 0.25% bupivacaine for the supraclavicular brachial block.

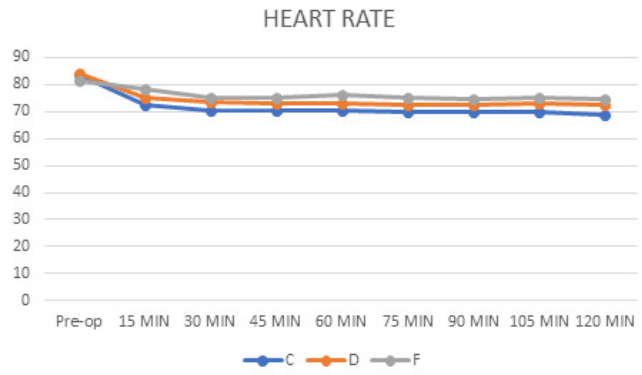

Figure 1: Line chart showing heart rate changes in all the groups

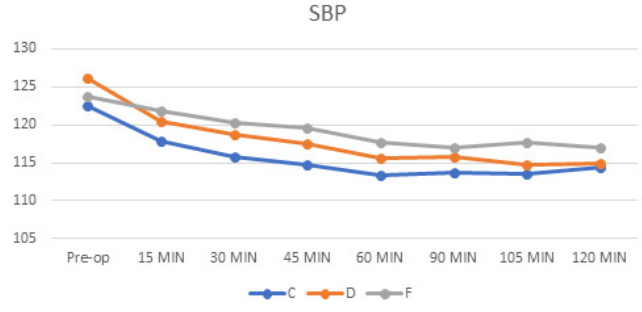

Figure 2: Line chart showing SBP changes in all the groups

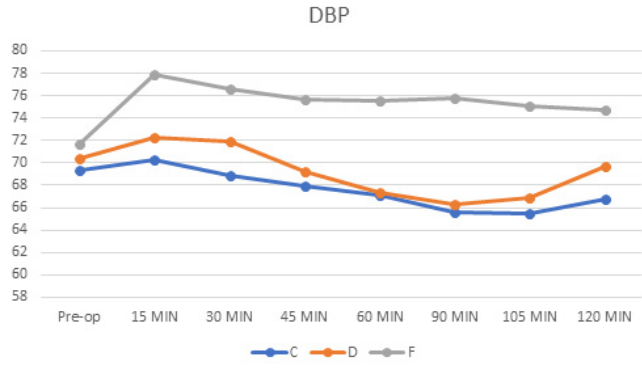

Figure 3: Line chart showing DBP changes in all the groups

Onset of Sensory and Motor Block

The mean onset time for sensory blockade for group C, i.e., clonidine, was 8.73 ± 0.98 minutes and motor onset time was 12.23 ± 1.57 minutes, while in a study conducted by Swami *et al.* where dexmedetomidine was compared with clonidine for supraclavicular block the mean onset time for the sensory block for clonidine was 2.33 ± 1.21 minutes and mean onset for motor block was 3.87 ± 1.78 minutes.[13] Somvanshi *et al.* reported it to be 4.53 ± 1.38 minutes for sensory block and 5.97 ± 1.77 minutes for motor block which was less than in our study, this can be explained by the difference in the amount of drug used in the two studies which was more in their study.[14]

In our study the mean onset time for a sensory block for group D, i.e., dexmedetomidine, was 7.37 ± 1.06 and 11.33 ± 1.6 minutes for a motor block. In a study, Palsule *et al.* evaluated the effect of adding dexmedetomidine as an adjuvant to 0.25% bupivacaine in supraclavicular block and reported the mean onset time for the sensory block to be 9.80 ± 7.29 minutes and for a motor block to be 11.83 ± 8.20 minutes which was similar to our study.[15] Swami *et al.* reported 1.77 ± 1.28 minutes for the sensory block and 4.65 ± 2.46 minutes for the motor block, which was less than in our study. This can be due to the amount of bupivacaine used in their study was more (35 mL).[13] In a study conducted by Lofty *et al.* for comparison between dexmedetomidine and fentanyl as adjuncts to bupivacaine for ultrasound-guided brachial plexus block the mean onset time for sensory block was 9.43 ± 728 and 9.30 ± 7.02 minutes for motor block for dexmedetomidine.[16]

In our study, the mean onset time for a sensory block in group F, i.e., fentanyl, was 7.13 ± 0.94 minutes and for the motor block was 9.77 ± 0.82 minutes. Puri A *et al.* reported it to be 5.66 ± 1.82 minutes for sensory block and 4.40 ± 0.63 minutes for motor block, which was less than in our study. This can be due to the use of lignocaine with adrenaline in their study.[17]

The mean onset of sensory and motor block was faster in group F, i.e., fentanyl, followed by group D, i.e., dexmedetomidine. Group C, i.e., clonidine has maximum onset time of sensory and motor block compared to fentanyl and dexmedetomidine.

Duration of the Block

In our study the duration of sensory block for clonidine was 507.30 ± 33.59 minutes and motor block was 552.73 ± 31.59 minutes, which was less in a study conducted by Somvanshi *et al.* who reported it to be 316.67 ± 45.21 minutes for sensory and 372.66 ± 44.48 minutes for motor block.[14] In a study by Ahmad *et al.*, the sensory block duration for clonidine was 558 ± 66.4 minutes and the duration of motor block was 574.3 ± 40.9, similar to our study.[18]

The duration of sensory block for dexmedetomidine in our study was 585.13 ± 44.42 minutes and for motor block was 546.07 ± 42.02 minutes which was similar to a study conducted by Chaudhary UK *et al.* for comparison of effects of dexmedetomidine and clonidine as adjuvant to bupivacaine 0.25% in ultrasound-guided supraclavicular brachial plexus block, reporting it to be 644.40 ± 62.47 minutes for sensory and 597.05 ± 150.84 minutes for the duration of the motor block.[19] In a study conducted by Lotfy *et al.* it was reported to be 459 ± 49.3 minutes for sensory block and 447.22 ± 25.6 minutes for the duration of motor block, which was less than our study. The probable cause for this can be the difference in the amount and dose of drug used in the two studies.[16]

In our study the duration of sensory block for fentanyl was found to be 330.03 ± 44.25 minutes and 284.67 ± 59.96 minutes for motor block. In a study conducted by Kumar *et al.* comparing Fentanyl and Nalbuphine as an adjuvant to 0.5% bupivacaine for ultrasound-guided supraclavicular brachial plexus block the duration for a sensory block for fentanyl was reported to be 466.87 ± 39.84 minutes and for motor block was 362.20 ± 34.31 minutes.[20]

Thus, the sensory and motor block duration was longest for dexmedetomidine and clonidine, followed by fentanyl, the difference being statistically significant.

First Rescue Analgesia

In our study the duration of analgesia for clonidine was 552.73 ± 31.59 minutes. In a study done by Swami *et al.*, time to first rescue analgesia was 284.67 ± 59.96 minutes for clonidine.[13] Kelika *et al.* evaluated clonidine as adjuvant to brachial plexus block and its comparison to tramadol the duration of analgesia was reported to be 470.7 ± 38.6 minutes with in clonidine in a dose of 1 μg/kg.[21]

The duration of analgesia was 612.97 ± 41.13 minutes for dexmedetomidine in our study, while Palsule *et al.* in a study reported it to be 735.67 ± 283.72 minutes.[15] Manjunatha *et al.* in a study for comparison of bupivacaine with dexmedetomidine as an adjuvant versus bupivacaine alone in USG-guided SCB reported the duration of analgesia with dexmedetomidine to be 1094 ± 132.8 minutes.[22]

In our study, the duration of analgesia for fentanyl was 353.30 ± 44.57 minutes, similar to the study conducted by Lotfy *et al.*, which reported it to be 361.2 ± 20.7 minutes.[16] Puri A *et al.* in a study for comparison of fentanyl and clonidine as adjuncts to a mixture of local anesthetics in potentiating post-operative analgesia in supraclavicular block, reported the duration of analgesia for fentanyl to be 8.79 ± 1.50 hours.[17] Kumar *et al.* reported it to be 660.67 ± 31.77 minutes.[20]

The time for the requirement of first rescue analgesia was shortest for fentanyl and maximum for dexmedetomidine, which was statistically significant.

Hemodynamic Stability

Our study observed that the study subjects' baseline heart rate was higher pre-operatively before the administration of drugs under study. In all the groups, heart rate was reduced by 30 minutes post-drug delivery and remained fairly constant thereafter.

The hemodynamic changes observed were similar in all the groups for all three parameters studied. The pattern in change was also similar. Thus, all three drugs had the same hemodynamic safety profile. Our study was similar to the study conducted by Lotfy *et al.*, where there were no significant differences in the heart rate and meant arterial blood pressure among groups.[16] In a study conducted by Palsule *et al.* evaluating the effect of dexmedetomidine as an adjuvant to 0.25% bupivacaine in supraclavicular block reported no significant changes hemodynamically.[15]

CONCLUSION

Thus, we concluded that adding fentanyl to bupivacaine for supraclavicular brachial plexus block had a faster onset of sensory and motor blockade when compared to dexmedetomidine and clonidine, and dexmedetomidine prolonged the duration of analgesia when compared with clonidine and fentanyl.

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