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Dexmeditomidine And Fentanyl As An Adjunct To Bupivacainein Supraclavicular Nerve Block

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ABSTRACT

Objective: The objective of the study was to evaluate the influence of the combination of dexmedetomidine and fentanyl with bupivacaine on the efficacy of ultrasonic guided supraclavicular nerve block for upper limb surgeries. Material and Methods: The study comprised a sample of 150 patients who were scheduled to have upper limb procedures at the Department of Anaesthesia in a Tertiary Care Teaching Institute in India. A total of 150 patients were divided into three groups. Group A was administered a combination of Bupivacaine and saline, Group B received Bupivacaine along with dexmedetomidine, and Group C was given Bupivacaine in combination with fentanyl. The essential parameters of heart rate, systolic and diastolic blood pressure, and oxygen saturation were documented. Results: Both the B Group and C Group exhibited a more rapid initiation and extended duration of sensory and motor blockade, which was statistically significant ($P<0.05$). Group B had a longer duration of pain relief after surgery compared to Group C and Group A. Conclusion: The administration of dexmedetomidine and bupivacaine in the supraclavicular block effectively reduced the onset time of both sensory and motor blocks. Furthermore, the administration of both dexmedetomidine and bupivacaine resulted in a significant reduction of postoperative discomfort.

Keywords : Bupivacaine, Dexmedetomidine, Fentanyl, Supraclavicular block.

INTRODUCTION

Regional nerve blockade is a valuable alternative to general anaesthesia, as it helps patients with cardiorespiratory comorbidities avoid the potential side effects of anaesthetic drugs. When utilizing a landmark technique for regional blockade, there is a possibility of inadequate nerve localization due to anatomical differences or previous trauma in the area. This can lead to unsuccessful anaesthesia or potential complications. Surface ultrasonography is a highly efficient method for identifying the neural components of the brachial plexus and the surrounding structures in the upper arm.(Folino and Mahboobi, 2020, Waindeskar et al., 2016) This method entails administering a block at the location where the nerves are densely packed around the trunks. This enables a quick and effective block to be established. Ultrasound-guided brachial plexus block provides the advantage of accurate nerve identification, real-time imagings of the brachial plexus, blood vessels, needle positioning, and the distribution of local anesthetic. It minimizes the need for several needle insertions. Several drugs, such as epinephrine, α2 agonist, corticosteroids, bicarbonate, and opioids, have been used to prolong the effects of local anesthetic in the supraclavicular block.(Rwei et al., 2018, Pester et al., 2017) The supraclavicular nerve block has the possibility of rare but severe outcomes such as pneumothorax, phrenic nerve block, Horner syndrome, neuropathy, and nerve injury.(Abdallah and Brull, 2013) Various additives have been used into local anesthetics to prolong the duration of the block and offer relief from postoperative discomfort. Commonly employed adjuvants encompass opioids, midazolam, magnesium sulphate, dexamethasone, and neostigmine. (Kaniyil and Radhakrishnan, 2017) These medications have been suggested and researched for their ability to decrease the time it takes for anaesthesia to start, extend the pain relief period, and decrease the risk of side effects, prolonged motor block, and the overall amount of local anesthetic drugs needed. Lately, there has been a surge in interest regarding alpha-2 receptor-stimulating medications due to their impressive sedative effects, analgesic properties, and ability to offer consistent anaesthesia while keeping hemodynamic stability.(Kettner, 2013, Pester et al., 2017)

Dexmedetomidine is a potent and selective α2-adrenergic agonist. When given systemically, it shows pain-relieving, blood pressure-lowering, calming, and anesthesia-enhancing properties.(Ammar and Mahmoud, 2012, Esmaoglu et al., 2010) Research indicates that adding Dexmedetomidine to local anesthetics can improve the efficacy of peripheral nerve blockade and regional anesthetic procedures. By incorporating dexmedetomidine with local anesthetic in various regional blocks, it is possible to prolong the block's duration and enhance post-operative pain management. Reports indicate that it has been demonstrated to enhance the effectiveness of intrathecal, caudal, and epidural anesthesia. There has been a recent description of the use of peripheral nerve blocks.(Obayah et al., 2010, Rancourt et al., 2012, Kettner, 2013)

Numerous studies have investigated the use of local anesthetics in combination with other substances.(Ammar and Mahmoud, 2012, Esmaoglu et al., 2010) Using a single drug to improve block quality by adding local anesthetic is not recommended.(Kumar et al., 2018) Regional nerve plexus

blocks have incorporated the use of opioids such as fentanyl to improve the duration and effectiveness of the block. Administering opioids peripherally provides stronger and longer-lasting pain relief, with no negative impact on the central nervous system. Research has demonstrated that the use of fentanyl can prolong and improve the efficacy of brachial plexus block.(Wang et al., 2018) Research has demonstrated that incorporating dexmedetomidine and fentanyl into local anesthetics for neuraxial and peripheral nerve blocks substantially prolongs the duration of both sensory and motor blockade.(Abdallah et al., 2015)

The objective of the study was to evaluate the influence of the combination of dexmedetomidine and fentanyl with bupivacaine on the efficacy of ultrasonic guided supraclavicular nerve block for upper limb surgeries.

METHODS

The research was carried out on a cohort of 150 individuals who were slated to have upper limb surgery at a renowned educational medical facility in India. The trial was designed to be randomized and double-blind, and it spanned duration of one year. (Ethical Approval Ref No: MKSMCRC/IEC/SER/2141). Once the patients have given their written informed consent for anaesthesia, they are provided with a thorough explanation of the study's nature and potential complications. 150 patients were divided into three groups using a random allocation process. Prior to the surgery, all patients were administered an intravenous injection of Midazolam at a dosage of 0.05mg/kg and Fentanyl at a dosage of 0.5 μg/kg, 15 minutes in advance. The fundamental heart rate, maximum blood pressure, minimum blood pressure, and oxygen saturation were recorded. A cannula with a gauge size of 18 was placed into the arm that was not operated on in order to inject a solution called lactated Ringer's.

The study involved individuals between the ages of 18 and 60, weighing between 55 and 85 kg, and classified as American Society of Anesthesiologists physical status Classes I and II. These individuals were set to undergo surgeries on their upper limbs, including procedures for fractures and plastic surgeries, lasting no longer than 2 hours.

The excluded individuals had local infections at the puncture site, neurological concerns in the upper limb, a history of blood disorders or clotting problems, severe liver damage, or documented hypersensitivity to the medicine or additives.

The patients were classified into three study groups using computer-generated random numbers. Each group consists of 50 patients.

- Group A, the control group, received a combination of bupivacaine and saline
- Group B: Bupivacaine combined with dexmedetomidine
- Group C: Bupivacaine combined with fentanyl

The individual was reclining on their back with their head raised at a 45° angle. With a pillow positioned under their shoulder, their head was tilted 45° in the opposite direction. After preparing the skin, an ultrasound is used with a linear probe placed in the coronal plane in the supraclavicular fossa to get the best view of the brachial plexus. The skin and subcutaneous tissue were numbed by injecting 2-4 ml of 2% lidocaine. The precise insertion of a 22 gauge Short bevel needle was carefully performed at the outside end of the probe. The needle was directed parallel to the length of the probe until it reached the circular, pulsating hypoechoic subclavian artery, which is situated above the hyperechoic first rib. The medication was given as a single injection of 0.5 mL per kilogram, with a maximum dose of 40 mL. The dosage of bupivacaine given was 1.5 mg per kilogram of body weight. Group A received a 0.5% dose of isobaric bupivacaine for anesthesia. Group B received a dose of 1 mg/kg of dexmedetomidine along with equal amounts of 0.5% isobaric bupivacaine. Group C participants received a dose of 1 mg/kg of fentanyl along with equal amounts of 0.5% isobaric bupivacaine. Scientists investigated the initiation and length of sensory and motor blockage.

The assessment of sensory block was conducted using a pin prick test, employing a 3-point scale.

0 = normal sensation

1 =loss of sensation of pin prick

2 = loss of sensation of touch

Motor block was determined according to the modified Bromage scale scale

The pinprick sensation was monitored at regular intervals, starting from the onset of loss of sensation until it was regained. The motor blockade was evaluated at 3-minute intervals until the cessation of movements, and then at 15-minute intervals until movement was restored. Vital signs such as heart rate, systolic blood pressure, diastolic blood pressure, and oxygen saturation levels were recorded every 15 minutes.

The duration of pain relief was assessed using the Visual Analogue Scale (VAS), which measures pain on a scale from 0 to 10. The scale was monitored hourly after the surgery until it reached a value of 5. Subsequently, analgesics were administered. The administered medication was Inj. Diclofenac sodium at a dosage of 1.5 mg per kilogram, delivered via an intramuscular injection. The timing of the administration was documented. Patients were closely observed for potential problems during and after surgery for a maximum of 48 hours. The accompanying proforma includes comprehensive documentation of all the particulars and data on each patient.

The study focused on analyzing and comparing various secondary outcomes, such as the time it took for sensory block to occur, the time it took for motor block to occur, and the duration of motor block across different groups.

The data was gathered and inputted into a spreadsheet software (Microsoft Excel 2007) prior to being transferred to the data editing section of SPSS version 15 (SPSS Inc., Chicago, Illinois, USA).

The presentation of numerical data required the use of metrics such as means and standard deviations, or median and interquartile range, depending on their distribution. The qualitative data was presented through the use of numerical values that accurately depicted the frequency and proportion of each category. The experiments were carried out with a confidence level of 95% and a significance level of 5%.

An optimal local block should have a quick onset time and long-lasting pain relief and muscle relaxation, all while avoiding any negative side effects. Recent research has emphasized the effectiveness of dexmedetomidine in extending the duration of the block. Furthermore, there was a heightened risk of bradycardia, hypotension, and drowsiness.

Stimulating the presynaptic receptor in the central nervous system inhibits the release of norepinephrine, resulting in a decrease in the transmission of pain signals. Dexmedetomidine induces a tranquil slumber in the patient by exerting its effects on the Locus coeruleus. There have been no reported cases of nerve damage associated with dexmedetomidine use. Based on the research by Brummett et al no axonal or myelin damage was detected in rats after 24 hours and 14 months.(Hamed et al., 2018, Carollo et al., 2008)

There was no statistically significant difference observed among the three groups in terms of gender, weight, age, and type of operation. ($P > 0.05$) (Table 1).

Table 1. : Studied patients' demographic data and surgical characteristics.

Variables	Group A	Group B	Group C	P value
Age (years)	29.1±7.5	32.78±9.3	30.96±9.2	0.25
Weight (kg)	72.5±6.107	71.23±6.5	73.22±7.7	0.36
Gender (%)				
Male	42 (84)	35 (70)	37 (74)	0.65
female	8 (16)	15 (30)	13 (26)	
ASA physical status (%)				
I	44 (88)	43 (86)	42 (84)	0.1
II	6 (12)	7 (14)	8 (16)	

Table 2 indicates a statistically significant distinction in the overall length of sensory and motor functions across the groups being studied. Group II had the highest mean for sensory duration (820.28±77.68) and motor duration (777.57±72.10), while Group A had the lowest mean for sensory duration (514.56±38.36) and motor duration (466±47.8). Group C had intermediate values for sensory duration (470.65±48.2) and motor duration (432.26±45.1) between the two groups.

Furthermore, there was statistically significant disparity in the commencement of sensory and motor duration among the study groups. Group B has a lower mean for sensory duration (04.50 ± 8.24) and motor duration (05.97 ± 2.03), while Group A has a higher mean for sensory duration (10.45 ± 01.48) and motor

duration (10.20 ± 08.45). Group C falls between the two groups, with sensory duration of 14.1±3.2 and motor duration of 15.8±3.9. (Table 2)

Table 2: Patients' Supraclavicular Block Characteristics in Three Groups

Variable	Group A	Group B	Group C	P value
Onset time of motor block	15.8±3.9	05.97 ± 2.03	10.20 ± 08.45	0.01*
Onset time of sensory block	14.1±3.2	04.50 ± 8.24	10.45 ± 01.48	0.01*
Duration time of motor block (Min)	466±47.8	777.57±72.10	432.26±45.1	0.003*
Duration time of sensory block (Min)	514.56±38.36	820.28±77.68	470.65±48.2	0.004*
First analgesia request (Min)	378.65±35.47	457.68±126.50	310.45 ± 108. 20	0.01*

*Statistically Significant

There is no statistically significant disparity observed in the intraoperative heart rate (HR) follow-up during the initial hour between the study groups. This indicates that all categories of medications had a uniform impact on intraoperative heart rate. Nevertheless, there exists a statistically significant disparity in intraoperative heart rate (HR) after 2 hours between Group A and C, with Group C exhibiting a lower HR. There is a statistically significant disparity in postoperative heart rate (HR) after 3 hours between Group C and both Group A and Group B. Moreover, there is a notable disparity between Group B and Group C regarding the postoperative heart rate (HR) at 5 and 6 hours, with Group C exhibiting a decrease in HR. The value of p is ≤ 0.05. There is no statistically significant disparity in the average arterial blood pressure (MBP) after 45 minutes of operation across the research groups. Nevertheless, there exists a statistically significant disparity in high mean blood pressure (MBP) between Group C and Group A, specifically within Group C. Group B and Group C show a notable disparity in MBP (mean blood pressure) after 10, 20, and 30 minutes, with Group B exhibiting low MBP. Group B and Group C exhibit a statistically significant disparity in mean blood pressure (MBP) at 2 and 6 hours post-operation. Furthermore, there is a notable disparity in the mean blood pressure (MBP) following surgery between Group B and Group A, particularly at 4, 5, and 6 hours post-procedure, where Group B had lower MBP levels. The value of p is ≤ 0.05.

According to recent research, using a combination of dexmedetomidine and bupivacaine for ultrasound guided supraclavicular nerve block has shown promising results. It leads to a quicker onset of sensory and motor block, and provides longer-lasting pain relief compared to using fentanyl or bupivacaine alone. In addition, it was discovered that fentanyl was more effective in achieving these outcomes compared to bupivacaine alone. The heart rate, respiratory rate, non-invasive arterial systolic blood pressure (SBP),

diastolic blood pressure (DBP), and peripheral oxygen saturation (SpO2) were recorded.(Hamed et al., 2018, Das et al., 2014, Pester et al., 2017)

Our research revealed statistically significant results in the duration of sensory blockage and motor blockade. Researchers Santhanababu, V. (2017)(Santhanababu, 2017) and Rachana Gandhi et al(Gandhi et al., 2012) conducted studies to investigate the effects of combining Dexmedetomidine with Bupivacaine in supraclavicular block. The time it took for the motor and sensory effects to occur decreased significantly. Kenan et al conducted a study which found that the combination of Dexmedetomidine and Levobupivacaine in axillary block did not result in a faster onset of motor block. (Kaygusuz et al., 2012, Pester et al., 2017) However, it did lead to a faster initiation of sensory block.

There is a notable disparity between the study groups regarding the commencement of sensory and motor duration. One group showed lower means for sensory and motor duration, while the other group displayed higher means for both sensory and motor duration. Group C's sensory duration was 14.1±3.2 and motor duration was 15.8±3.9, placing it between the other two groups. Murphy et al. and Brummett et al. examined the utilization of dexmedetomidine as a supplementary agent to local anesthetics. They emphasized that the precise analgesic mechanism of dexmedetomidine is still uncertain and may involve multiple components.(Murphy et al., 2000, Brummett et al., 2011) Dexmedetomidine has been investigated by various Authors.(Lee et al., 2016, Swami et al., 2012) Various different mechanisms have been proposed to explain its effects. One mechanism of action is inducing vasoconstriction by targeting α2 adrenoceptors. Another way it works is by creating pain relief in the body's outer regions through a decrease in norepinephrine release and an increase in potassium conduction in pain neurons. Furthermore, it elicits central pain relief and sedation by inhibiting the production of substance P in the pathway responsible for transmitting pain signals. These effects occur specifically at the dorsal root ganglia and locus coeruleus.

The results of our study indicate a statistically significant difference in intraoperative heart rate (HR) between the fentanyl group, dexmedetomidine group, and bupivacaine group. The fentanyl group exhibited a lower HR, which can be attributed to the relationship between fentanyl and bradycardia mediated by the vagus nerve. Esmaoglu et al conducted a study where they observed bradycardia in patients who were given a combination of 100 μg of Dexmedetomidine and Levobupivacaine.(Esmaoglu et al., 2010) Our study on supraclavicular brachial plexus block did not observe any technical complications like hematoma or pneumothorax. All participants in the study displayed no indications of respiratory depression.

Group B had a significantly reduced mean pain score, as assessed by the Visual Analog Scale (VAS), in comparison to Group C and Group A after the surgical procedure. The value of p is less than or equal to 0.05. Neither research group exhibited any problems or notable side effects.

The addition of fentanyl has been observed to increase the length of time that anesthesia lasts and improve pain management after surgery by one hour, compared to the group that did not get fentanyl. These findings are consistent with the research conducted by Sarita et al, and Aliye Esmaoglu et al, all of whom saw comparable effects in prolonging the duration of sensory and motor blocks.(Chavan et al., 2011)

The quality of anesthesia was superb in all three groups of the trial, and there were no instances of block failure that required the use of general anesthesia. Administering dexmedetomidine at a dosage of 1 mg/kg could be a favorable option as an adjunctive therapy for supraclavicular brachial plexus block, as it induces drowsiness without causing any detrimental impact on blood pressure or other undesirable symptoms.

Patients were closely observed for any potential complications during the surgery and for a period of 48 hours after the treatment. The information of each patient was properly documented in the given form. Neither of the trial groups experienced any issues or significant side effects.

Highlighting that our study involved a limited number of participants, which could impact the broad applicability of our results. In order to draw stronger conclusions, it is important for future studies to incorporate larger sample sizes. Another concern revolved around the expensive price and restricted supply of dexmedetomidine vials. Combining dexmedetomidine with supraclavicular nerve block results in a faster onset of the block and prolonged relief from postoperative pain.

CONCLUSION

When dexmedetomidine and bupivacaine were used together in the supraclavicular block, there was a notable reduction in the time it took for sensory and motor blocks to become effective. The duration of sensory and motor blocks was prolonged without any notable side effects such as low blood pressure and slow heart rate. Furthermore, the combination of dexmedetomidine and bupivacaine proved to be highly effective in reducing postoperative pain. Further, studies at variable drug-dose combinations are recommended to validate the findings of present study and also to determine the optimum and the most effective dose of local anaesthetic and adjuvants.

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