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A RANDOMIZED STUDY COMPARING THE EFFICACY OF ULTRASOUND GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK USING 0.5% BUPIVACAINE ALONE AND COMBINATION OF 0.5% BUPIVACAINE AND BUPRENORPHINE IN PATIENTS UNDERGOING ELECTIVE UPPER LIMB ORTHOPAEDIC SURGERIES

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ABSTRACT

Background: Many adjuvants have been tried to enhance the analgesic efficacy of local anaesthetics in supraclavicular brachial plexus block. From previous studies, it was noted that opioids added to local anaesthetics produce comparable analgesia in supraclavicular brachial plexus block. Hence, in my study, I have compared a group of patients who received bupivacaine alone with the other group of patients who received the combination of bupivacaine and buprenorphine.

Methods & Methodology: With Institutional ethical committee approval and written informed consent, we conducted double-blind, randomized study with two groups of 30 patients each. The supraclavicular brachial plexus block was performed in elective upper limb surgeries to compare the efficacy of analgesia with 0.5% bupivacaine alone and a combination of 0.5% bupivacaine and buprenorphine in patients undergoing elective upper limb orthopaedic surgeries with respect to onset and duration of blockade. Visual analogue scale (VAS) scores were evaluated at fixed interval for 24 hours postoperatively in all patients.

Result: Onset of motor blockade delayed in group II (9.70 min) compared to group I (9.27min). VAS score was found to be better in group II (12hrs) than in group I (6-8hrs). Time to first rescue analgesia was prolonged in group II (13.10hrs) than in group I (7.10hrs).

Conclusion: The results showed that buprenorphine enhance and prolong the analgesic effect of bupivacaine when used for supraclavicular brachial plexus block in patients undergoing elective upper limb orthopaedic surgeries.

KEYWORDS: Analgesia, brachial plexus block, buprenorphine, ultrasound

INTRODUCTION

Ultrasound-guided supraclavicular brachial plexus block has emerged as an advanced anaesthesia technique for upper limb surgeries due to the fact that it offers visualization of the brachial plexus, needle movement, and spread of the local anaesthetic, which leads to accurate blocks and reduced risks of complications, including unintentional intravenous drug administration and pneumothorax (Elmaghraby et al., 2021). Compared to the traditional landmark technique, ultrasound guidance facilitates accurate needle positioning, ensures optimal distribution of local anaesthetics, and promotes better blocks (Biswas & Barua, 2020). Thus, ultrasound guidance has become an effective technique for upper limb orthopaedic surgeries (Hassan et al., 2020). The benefits of regional anesthesia include intraoperative anesthesia, good postoperative analgesia, hemodynamic stability, lower opioid usage, and faster postoperative recovery (Ghasemi et al., 2023). The supraclavicular approach among other methods of brachial plexus anesthesia gives dense sensory and motor anesthesia owing to the tight packing of the nerve trunks, making it an ideal technique for surgical procedures of the arm, forearm, and hand (Gupta et al., 2024). The above benefits are some of the reasons why supraclavicular brachial plexus block using ultrasound guidance is increasingly becoming common in orthopedic surgery.

Bupivacaine is one of the most frequently used long-acting local anesthetics in supraclavicular brachial plexus block due to its efficacy in providing sensory and motor blockade with prolonged anesthetic effect (Pyakurel et al., 2023). Nevertheless, postoperative analgesia using bupivacaine alone might be inadequate for prolonged analgesic effects after orthopedic surgeries. For this reason, various pharmacological adjuvants have been examined in order to increase block time, provide better analgesic effect, and decrease the need for rescue analgesics (Edinoff et al., 2021). Recent clinical trials have shown enhanced analgesic results due to the addition of adjuvants to bupivacaine in ultrasound-guided

supraclavicular brachial plexus block (Hussain et al., 2023). Similarly, comparable results have been found using other local anaesthetic-opioid combinations in upper limb surgeries (Jain et al., 2022). Out of all the available adjuvants, buprenorphine has emerged as a popular choice due to its high lipophilicity, high μ-opioid receptor affinity, and prolonged analgesic effects (Luo et al., 2024). In previous researches, it has been shown that perineural buprenorphine prolongs postoperative analgesia, increases the delay before the need for rescue analgesia, and enhances patient comfort without inducing any haemodynamic or respiratory instability (Lomate & Mane, 2020). Other comparative studies have also found that buprenorphine is an effective and safe adjuvant in ultrasound guided brachial plexus block (Ammanamanchi & Huilgol, 2025). Similarly, comparable results have been found in buprenorphine based adjuvant therapy for upper limb regional anaesthesia (Royhan et al., 2023).

Several other adjuvants, such as nalbuphine, dexmedetomidine, dexamethasone, magnesium sulphate, fentanyl, and morphine, have also been tested for ultrasound-guided brachial plexus block; however, their impact on block characteristics and postoperative analgesia has been variable (Kalika et al., 2020). Randomized comparative trials have shown varying durations of analgesia and quality of blocks among these drugs, and thus the best adjuvant is still unclear (Mohamed & Gad, 2021). Other prospective studies have also confirmed the improvement in the quality of blocks using various combinations of adjuvants (Patra et al., 2022). Moreover, systematic reviews and meta-analyses have discussed the increasing importance of adjuvant medicines and the necessity of more clinical trials to find out the most efficient adjuvant combination (Kumar & Jaiswal, 2024). The same observations were made by comparative clinical trials involving various adjuvants for peripheral nerve blocks (Margulis et al., 2021).

Despite all this, there is insufficient information in literature regarding the effect of adding buprenorphine (3 μg/kg) to 0.5% bupivacaine for supraclavicular brachial plexus block guided by ultrasonography in patients having elective upper limb orthopaedic surgery. Several recent studies have further stressed the importance of choosing an appropriate adjuvant for regional anaesthesia. Hence, the current randomized and double-blind comparative investigaion was conducted to compare the effects of Comparing 0.5% bupivacaine with buprenorphine (3 μg/kg) against 0.5% bupivacaine alone in terms of hemodynamic stability, postoperative analgesia, time to first rescue analgesic demand, and the onset and duration of sensory and motor blockade, respiratory parameters, postoperative pain, sedation, and side effects.

Objectives of the Study

- To compare the efficacy of ultrasound-guided supraclavicular brachial plexus block using 0.5% bupivacaine alone and 0.5% bupivacaine with buprenorphine (3 μg/kg) in patients undergoing elective upper limb orthopaedic surgeries.
- To compare the onset of sensory and motor blockade, duration of postoperative analgesia, and time to first rescue analgesic requirement among the two groups.
- To compare haemodynamic parameters, respiratory parameters, postoperative pain scores, sedation, and adverse effects between the two study groups.

2. METHODOLOGY

2.1 Study Design and Participants

The current randomized and double-blind comparative investigation was executed after receiving the necessary permission from the Institutional Ethics Committee of Adichunchanagiri Institute of Medical Sciences (Approval Number: AIMS/IEC/32/2022). A total number of 60 adult patients among the ages of 18 and 60 years, who were ASA Physical Status I & II patients suffering elective upper limb orthopedic surgeries under ultrasound-guided supraclavicular brachial plexus block were included after obtaining their written informed consent. Patients who refused to contribute in the investigation, suffering from peripheral neuropathy, bleeding disorders, known hypersensitivity to the drugs used in the study, local infection at the site of injection, or those with history of seizures were excluded from the investigation. All eligible individuals underwent thorough pre-operative evaluation and the procedure, its benefits over GA, risks involved in the procedure and the use of VAS scale was explained to all patients.

2.2 Randomization and Study Groups

After verifying their eligibility, the subjects were at random allocated into two equally divided groups of 30 individuals each with the help of computer-generated random number tables. The investigation medications were arranged by an independent anaesthetist who had no role in collecting data in order to keep the study blind. Group A received a total of 20 mL, which comprised 19 mL of 0.5% bupivacaine with 1 mL of normal saline. On the other hand, Group B received a total of 20 mL, which comprised 19 mL of 0.5% bupivacaine and 1 mL of normal saline along with buprenorphine (3 μg/kg). The anaesthetist carrying out the ultrasound guided supraclavicular brachial plexus block remained blinded, but all the intra-operative or post-operative observations were documented by the same anaesthetist.

2.3 Ultrasound-Guided Supraclavicular Brachial Plexus Block Procedure

Standard monitoring was carried out in the operation room, including non-invasive blood pressure monitoring, pulse oximetry, and ECG, and baseline haemodynamic parameters were obtained. The IV line was secured, maintenance fluids were given, and intravenous midazolam (0.01 mg/kg) was administered to alleviate anxiety. Oxygen supplementation was provided at 3-5 L/min via face mask. The patient was positioned in a supine position with their head rotated 45 degrees to the side and their arms adducted. The brachial plexus was found using a high-frequency linear ultrasound probe operating at 8–13 MHz. The supraclavicular brachial plexus block guided by ultrasonography procedure and the anatomical landmarks seen during needle insertion are shown in Figure 1. An 18-gauge needle was introduced with in-plane method, and once the negative aspiration test was done, the 20 mL of study solution was vaccinated in the corner pocket while still under ultrasound guidance and then dressed in sterile manner.

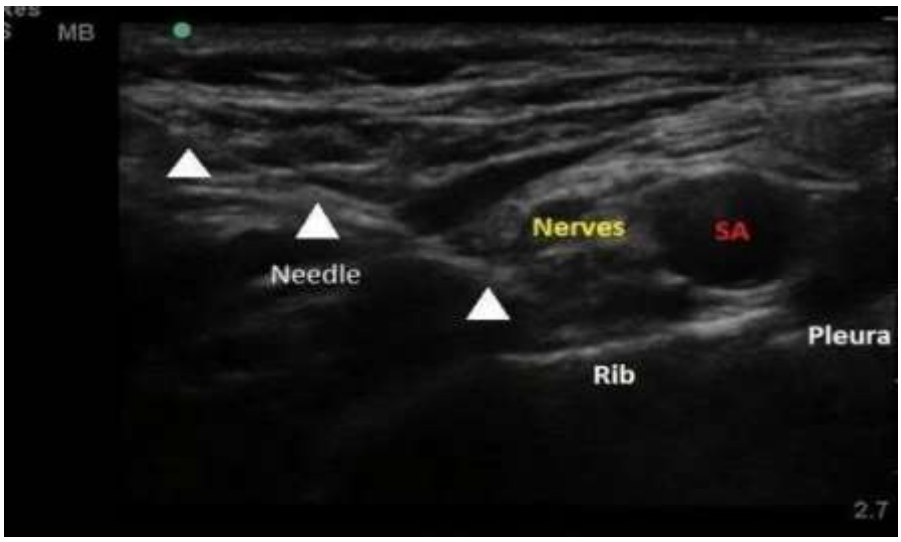

Figure 1. Ultrasound-guided supraclavicular brachial plexus block.

2.4 Outcome Assessment

The time of start, duration, or quality of sensory or motor block, period of postoperative analgesia, need for rescue analgesia and more sedation, or general anesthesia, and the occurrence of any side effects were analyzed throughout the study. The sensory block was assessed at 5-minute intervals for 30 minutes using a pinprick test with a blunt 23-gauge hypodermic needle and was classified on a three-point scale. The motor block was evaluated at 5-minute intervals for 30 minutes using the modified Bromage three-point scale. The Visual Analogue Scale was used to measure postoperative pain every five minutes for the first thirty minutes, every thirty minutes for the next eight hours, and then every hour until a VAS score of four was reached.

2.5 Sample Size Estimation

Sample size assessment was done founded on the information collected during the pilot study that revealed a mean time for analgesia of 4.43 ± 0.62 hours in Group I and 5.05 ± 1.65 hours in Group II. Sample size estimation was done at the significance level of 5% ($Z_{1-\alpha/2} = 1.96$) and a power of the study of 85% ($Z_{1-\beta} = 1.037$). According to the calculated pooled standard deviation and expected alteration among the groups, the sample size was found to be approximately equal to 60 participants. Therefore, 60 participants were included in the investigation, with 30 subjects in each experimental group. It is assumed that such a sample size is enough to compare the effectiveness of bupivacaine and bupivacaine with buprenorphine supraclavicular brachial plexus block under ultrasound guidance.

2.6 Statistical Analysis

Statistical examination was done by Statistical Package for Social Sciences (SPSS) software version 20.0. Continuous information were expressed as mean ± SD, while categorical information were articulated in terms of frequency and percentage. Student's t-test was employed for comparison of continuous information among the two groups, while Chi-square test was used for comparison of categorical information. The p-value of less than 0.05 was considered statistically substantial. This statistical examination technique was employed for comparison of demographic data, onset and period of sensory or motor block, period of analgesia, need for rescue analgesia, hemodynamic data, respiratory data, postoperative pain scores, sedation scores, and other intraoperative data.

3. RESULTS

3.1 Demographic Features

The baseline demographic features of the subjects involved in the investigation are shown in Table 1 below. There were no statistically substantial alterations among the two groups concerning age (p= 0.17) or gender (p = 0.41). This means that the two groups were similar before the administration of the test drugs.

Table 1. Comparison of Demographic Parameters

Variable	Group A (Mean ± SD)	Group B (Mean ± SD)	P value
Age (years)	33.37 ± 11.17	38.17 ± 11.11	0.17
Sex distribution (Male: Female)	11:19	8:22	0.41

3.2 Sensory and Motor Block Characteristics

The start of sensory blockade was similar in both the groups, with Group A showing the onset time as 11.67 ± 0.76 minutes and Group B showing 11.50 ± 0.90 minutes (p = 0.44). The beginning of motor blockade, on the other hand, showed significant differences in the two groups. Group A had an earlier onset of motor blockade as compared to Group B (9.27 ± 0.74 minutes vs. 9.70 ± 0.79 minutes, p = 0.03) as shown in Table 2.

The administration of buprenorphine resulted in significantly prolonged postoperative analgesia. The duration of analgesia increased from 5.03 ± 0.24 hours in Group A to 10.08 ± 0.44 hours in Group B (p = 0.0001). Similarly, the time before which the first rescue analgesic was needed increased significantly from 7.10 ± 0.40 hours in Group A to 13.10 ± 0.96 hours in Group B (p = 0.0001).

Table 2. Comparison of Sensory and Motor Block Features

Variable	Group A (Mean ± SD)	Group B (Mean ± SD)	p-value
Onset of sensory block (minutes)	11.67 ± 0.76	11.50 ± 0.90	0.44
Onset of motor block (minutes)	9.27 ± 0.74	9.70 ± 0.79	0.03
Duration of analgesia (hours)	5.03 ± 0.24	10.08 ± 0.44	0.0001
Time to first rescue analgesia (hours)	7.10 ± 0.40	13.10 ± 0.96	0.0001

The comparison of sensory block onset, motor block onset, duration of analgesia, and time to first rescue analgesia among the two study groups is presented in Figure 2.

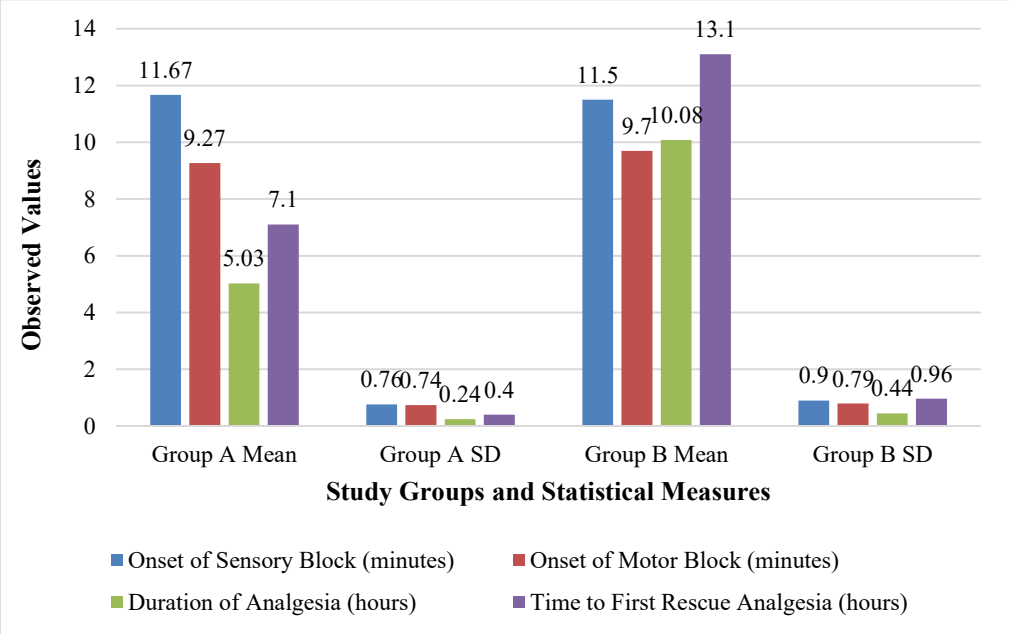

Figure 2. Comparison of Sensory and Motor Block Characteristics and Analgesic Outcomes Among Study Groups

Figure 2 illustrates the comparison of means and standard deviations of block and analgesic results. The time to sensory block was alike in both groups, while the time to in group A, motor block was noticeably earlier. The first rescue analgesia was delayed and the duration of analgesia was noticeably prolonged in Group B.

3.3 Haemodynamic Parameters

Intraoperative hemodynamic data are shown in Tables 3 and 4 and Figure 3. The pulse rate, mean arterial pressure, systolic blood pressure, and diastolic blood pressure values were stable during the entire study period in both groups. There were no substantial intergroup changes noted at any of the recorded time points.

Table 3. Comparison of Pulse Rate Among the Study Groups

Time	Pulse Rate G-I	Pulse Rate G-II
Baseline	79.93 ± 12.02	80.60 ± 10.87
5 min	78.97 ± 12.01	80.23 ± 9.87
10 min	78.70 ± 10.76	80.63 ± 9.72
15 min	78.70 ± 10.51	80.30 ± 8.57
30 min	78.50 ± 11.02	79.87 ± 9.79
60 min	78.50 ± 10.44	79.50 ± 9.44
90 min	78.43 ± 10.69	78.83 ± 9.82
120 min	78.40 ± 10.02	79.73 ± 9.77

Figure 3 illustrates the mean systolic blood pressure and corresponding standard deviations for both study groups throughout the observation period.

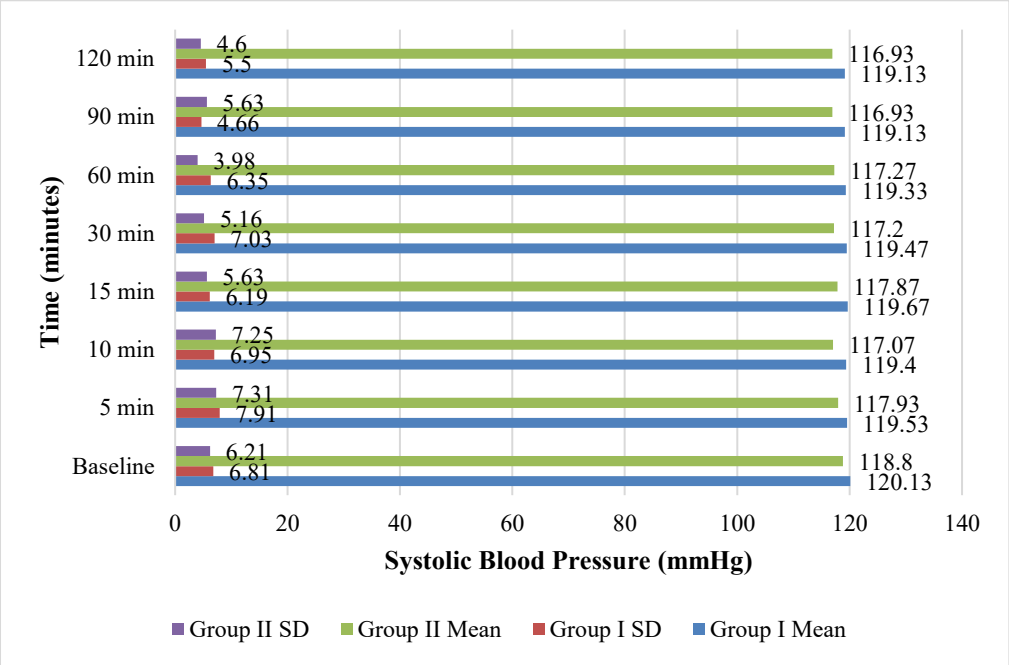

Figure 3. Systolic Blood Pressure by Group

As can be seen in Figure 3 below, the level of SBP was constant in both groups from the baseline up to 120 minutes, with some physiological variations. The values were similar for Group A and Group B at all measured times, suggesting that there was no clinical change in the SBP after administration of buprenorphine.

Table 4. Comparison of Diastolic Blood Pressure and Mean Arterial Pressure

Time	DBP G-I	DBP G-II	MAP G-I	MAP G-II
Baseline	74.20 ± 4.62	74.67 ± 3.25	89.13 ± 4.90	89.10 ± 3.45
5 min	73.67 ± 5.10	74.27 ± 3.74	88.63 ± 5.68	88.63 ± 4.04
10 min	73.73 ± 5.84	74.00 ± 3.32	88.67 ± 5.34	88.33 ± 3.33
15 min	73.33 ± 6.16	73.93 ± 2.95	88.50 ± 5.23	88.17 ± 2.71
30 min	73.07 ± 4.84	73.80 ± 2.43	88.20 ± 4.58	88.00 ± 2.48
60 min	73.07 ± 4.54	73.27 ± 1.34	88.17 ± 4.87	87.57 ± 1.81
90 min	73.13 ± 4.19	73.60 ± 1.43	88.03 ± 4.05	87.67 ± 2.17
120 min	73.20 ± 4.35	73.27 ± 2.00	88.13 ± 4.21	87.53 ± 2.08

3.4 Respiratory Parameters

The respiratory parameters are shown in Table 5. The Peripheral oxygen saturation and respiratory rate were within the normal physiological range in both groups at all times of measurement. No statistically significant intergroup differences were found at any point of measurement.

Table 5. Comparison of Respiratory Rate and Peripheral Oxygen Saturation

Time	Respiratory Rate G-I	Respiratory Rate G-II	SpO_2 G-I	SpO_2 G-II
Baseline	15.40 ± 0.50	15.40 ± 0.50	99.00 ± 0.00	99.00 ± 0.00
5 min	15.37 ± 0.49	15.37 ± 0.49	99.00 ± 0.00	99.00 ± 0.00
10 min	15.37 ± 0.49	15.40 ± 0.50	99.00 ± 0.00	99.00 ± 0.00
15 min	15.37 ± 0.49	15.37 ± 0.49	98.93 ± 0.25	99.00 ± 0.00
30 min	15.37 ± 0.49	15.37 ± 0.49	98.97 ± 0.18	99.00 ± 0.00
60 min	15.37 ± 0.50	15.37 ± 0.50	99.00 ± 0.00	99.00 ± 0.00
90 min	15.37 ± 0.50	15.37 ± 0.49	99.00 ± 0.00	99.00 ± 0.00
120 min	15.37 ± 0.49	15.37 ± 0.49	98.97 ± 0.18	99.00 ± 0.00
4 h	15.37 ± 0.49	15.37 ± 0.49	99.00 ± 0.00	99.00 ± 0.00
6 h	15.37 ± 0.49	15.40 ± 0.50	99.00 ± 0.00	99.00 ± 0.00
8 h	15.37 ± 0.49	15.37 ± 0.49	99.00 ± 0.00	99.00 ± 0.00
10 h	15.37 ± 0.49	15.37 ± 0.49	99.00 ± 0.00	99.00 ± 0.00
12 h	15.37 ± 0.62	15.37 ± 0.49	98.97 ± 0.18	99.00 ± 0.00
16 h	15.43 ± 0.57	15.33 ± 0.48	99.00 ± 0.00	99.00 ± 0.00

3.5 Postoperative Pain and Sedation

Pain after surgery was measured by Visual Analogue Scale, while sedation was measured by Ramsay Sedation Score. Pain control was better for group B, as expected because of longer period of analgesia and delayed need for rescue analgesic in group B. Sedation scores were alike among the groups during early postoperative period. Ramsay sedation scores were higher in group B at 10 and 12 hours, while they were similar at other assessment periods (Table 6).

Table 6. Comparison of Ramsay Sedation Scores

Time	Group I	Group II	p-value
Baseline	1.00 ± 0.00	1.00 ± 0.00	-
15 min	1.87 ± 0.35	1.90 ± 0.31	0.69
30 min	2.00 ± 0.00	2.00 ± 0.00	-
1 h	2.00 ± 0.00	2.00 ± 0.00	-
2 h	2.00 ± 0.00	2.00 ± 0.00	-
4 h	2.03 ± 0.18	2.00 ± 0.00	0.32
6 h	2.03 ± 0.18	2.00 ± 0.00	0.32
8 h	1.97 ± 0.18	2.00 ± 0.00	0.32
10 h	1.23 ± 0.43	2.00 ± 0.00	0.0001
12 h	1.00 ± 0.00	1.50 ± 0.51	0.0001
16 h	1.00 ± 0.00	1.00 ± 0.00	-

4. DISCUSSION

This current randomized, double-blind comparative investigation assessed the effect of addition of buprenorphine (3 μg/kg) to When executing an ultrasound-guided supraclavicular brachial plexus block for elective upper limb orthopaedic procedures, 0.5% bupivacaine is used. It was found that there was a substantial prolongation of postoperative analgesia as well as delay in the need for rescue analgesia without affecting the sensory block onset and haemodynamic/respiratory parameters. Though there was a slight difference in motor block onset, it can be concluded from the results that buprenorphine improves the analgesic effect of bupivacaine.

The baseline demographics of both the groups were similar, thus ensuring proper randomization and preventing any possible confounding factors. All the haemodynamic parameters, such as mean arterial pressure, systolic and diastolic blood pressure, and pulse rate, were kept constant during the intraoperative period. The peripheral oxygen saturation and respiratory rate also stayed within normal physiological limits, thereby implying that the administration of buprenorphine (3 μg/kg) had no negative impact on the cardiovascular system and respiratory system of the patients. This is supported by previous studies that have indicated the safety of ultrasound-guided supraclavicular brachial plexus block as a regional anaesthesia procedure (Tsao et al., 2023; Sabir et al., 2025). In the current study, the start of sensory block was found to be alike among the two groups, although the start of motor block was slightly delayed after buprenorphine administration. Most importantly, the administration of buprenorphine helped in increasing the period of postoperative analgesia and delaying the time to first request for rescue analgesia. These observations imply that buprenorphine is more active in increasing the period of analgesia rather than hastening the block onset. Similar observations have been made in randomized clinical trials which showed increased duration of postoperative analgesia after using buprenorphine as an adjuvant for ultrasound guided supraclavicular brachial plexus block (Sangeetha et al., 2024). Similarly, Suvajit et al. (2025) also observed that buprenorphine improved the duration of analgesia and block characteristics.

The prolonged analgesic outcome seen in this investigation could be attributed to the pharmacology of buprenorphine, which includes its lipophilicity, affinity for the μ-opioid receptor, and long receptor binding time, thus contributing to its analgesia effect on the periphery. As such, patients needed rescue analgesia significantly later than patients under bupivacaine alone, giving them better postoperative pain management. The outcomes of this investigation are reliable with those found in the review of Yang and Zhang (2022), where it was found out that opioid adjuvants work effectively in prolonging the analgesic effect of peripheral nerve blocks and having a good safety profile. The same findings were also found in the systematic review of Xiong et al. (2021). Postoperative pain management and patient safety continue to be important goals of regional anaesthesia. For this study, prolonged analgesia was associated with low postoperative pain scores, constant Ramsay Sedation Scores, and lack of any adverse effects from opioids or any compromise to respiration. The results reveal that there was successful analgesia with no sedation or systemic effects noted. Similar results were observed by Urits et al. (2020), who stressed the importance of proper selection of adjuvants that would enhance the quality and duration of peripheral nerve blocks while maintaining safety.

The results obtained from the study have several significant clinical implications. The use of buprenorphine (3 μg/kg) in combination with 0.5% bupivacaine effectively extended the period of postoperative analgesia and postponed the need for rescue analgesia without altering hemodynamic and respiratory stability. This may help in the effective management of postoperative pain, decline the use of adjuvant analgesics, and improve patient comfort after elective upper limb orthopedic surgery. There are some boundaries of the current investigation. First, it is a single-center investigation with a smaller number of participants, and only one dose of buprenorphine (3 μg/kg) was used. Second, there were no postoperative follow-up and patient satisfaction analysis performed in this investigation. Further investigations are needed in the form of multicenter randomized controlled trials with larger numbers of participants.

5. CONCLUSION

In the current study, which is randomized and double-blinded, the inclusion of buprenorphine (3 μg/kg) in the solution of 0.5% bupivacaine for supraclavicular brachial plexus block under ultrasound guidance improved postoperative analgesia in elective upper limb orthopaedic surgery patients. Although there was no significant difference in the time to start of sensory block, a slight difference was noted in the time to start of motor block, but the inclusion of buprenorphine along with bupivacaine resulted in prolonged period of analgesia and delayed the first rescue analgesia significantly. In addition to that, the haemodynamic status, oxygen saturation and respiratory rate level of the individuals were also maintained constant throughout the perioperative period, which suggested that there was no negative impact of using buprenorphine on the cardiovascular and respiratory systems of the patients. In addition to that, the postoperative pain relief was also enhanced, sedation was at acceptable levels, and no adverse effects related to opioids were detected. The results indicate that the use of buprenorphine (3 μg/kg) as an adjuvant to 0.5% bupivacaine is a safe and effective procedure, and it helps in achieving prolonged postoperative analgesia. Thus, the use of buprenorphine in the supraclavicular brachial plexus guided by ultrasonography block may be a good approach for perioperative pain management

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