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Original Research Article

ADJUVANTS TO ROPIVACAINE FOR SUPRACLAVICULAR BRACHIAL PLEXUS BLOCKS:IS NALBUPHINE A SUITABLE ALTERNATIVE?

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Abstract

Background: Multiple drugs including dexamethasone, dexmedetomidine or clonidine have been studied for their possible role and advantages when used as adjuvants in regional anesthesia. Among opioids with similar potential, Nalbuphine is a strong analgesic with mixed k agonist and μ antagonist action. It has been studied several times for its role as an adjuvant to local anesthetics in spinal, epidural and local infiltration but there are significantly fewer studies for the same in brachial plexus blocks. The aim of this study was to evaluate the effect of Nalbuphine as an adjuvant to 0.75%Ropivacaine in supraclavicular brachial plexus block and find out if it were a suitable alternative to obtain benefits of analgesia beyond the duration of anesthesia. **Materials and Methods:** In this prospective, randomized controlled, double-blind study, seventy patients undergoing elective upper limb surgeries were randomized into two groups – group R and group N. Both groups were administered Supraclavicular block under USG (ultrasonographic) guidance. Study group R (n = 35), received 29mL of 0.75% Ropivacaine + 1 mL normal saline. Study group N (n = 35), received 29 mL of 0.75% Ropivacaine + 1 mL (10 mg) Nalbuphine. Assessments were made of the following parameters of block characteristics: Onset and duration of sensory and motor block, duration of analgesia (DOA), and any adverse events. Data between the groups were analysed using independent t test with the statistical package for social science SPSS 21.0 software. **Result:** The duration of analgesia, sensory and motor block was significantly higher in those administered Nalbuphine as opposed to those administered Normal Saline along with Ropivacaine. There were no significant hemodynamic variations and no technique related complications or adverse effects due to Nalbuphine occurred. **Conclusion:** Nalbuphine 10mg with 0.75% Ropivacaine significantly extended the duration of analgesia in USG guided supraclavicular brachial plexus block with no significant adverse effects.

INTRODUCTION

For upper limb procedures, brachial plexus block is a dependable substitute for general anaesthesia. When administered properly, regional anesthesia / peripheral nerve blocks offer favorable operating circumstances. They have the dual advantage of providing excellent intraoperative anesthesia along with good post-operative analgesia. They practically obviate interference with the vital physiological functions of the body, facilitating a reduction in stress response and systemic analgesia requirements. Polypharmacy, opioid-related side effects and general anesthesia requirements can also be largely avoided with effective administration of regional nerve/plexus blocks.[1] The primary drawback of single shot peripheral nerve blocks is their limited duration of action, particularly if one considers how limited post-operative analgesia they offer.[2] The other main disadvantages are inadequate or failed block and local anesthetic toxicity both of which can be circumvented by utilization of USG guidance in the administration of such blocks[3].

Realtime ultrasonographic visualization of anatomical structures impart a greater degree of safety and accuracy to methods of regional blocks.

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With the help of USG, the anesthetist can achieve optimal needle positioning as well as visualize the distribution of local anesthetic in real time.[3]

Because it offers a more differential block when injected via the epidural route, ropivacaine, a novel local anaesthetic drug, is thought to be superior to bupivacaine. Ropivacaine also causes less cardiovascular and central nervous system toxicity as compared to Bupivacaine. When used in high concentrations for peripheral nerve/plexus blocks and epidural anaesthesia, its decreased systemic toxicity makes it a good local anaesthetic agent.[4]

The use of ropivacaine in brachial plexus blocks has grown, offering significant benefits.[5] Various drugs have evolved as adjuvants along with techniques such as a continuous catheter placement in a bid to obtain more prolonged durations of analgesia with brachial plexus blocks. It is desirable that these adjuvant drugs increase the duration of analgesia without causing any additional significant systemic adverse effects and prolonging motor blockade. The agonist-antagonist opioid nalbuphine,[6] has been investigated as an adjuvant for epidural block and SAB (subarachnoid block) and has been shown to be useful in prolonging the duration of block. While concurrently reducing the negative effects of μ-opioid-based analgesia, nalbuphine has the ability to preserve or even improve it. With a duration of action ranging from 3 to 6 hours and a dose range of 0.2–0.4 mg/kg, nalbuphine exhibits minimal adverse effects while maintaining cardiac stability [7,8]. Nalbuphine has a good safety record and can be used to treat burns, neoplastic conditions, and haematological disorders in children. A higher degree of analgesia makes Nalbuphine a more suitable alternative for day care surgery than other commonly used opioids.

. When used with ropivacaine for supraclavicular brachial plexus block, nalbuphine may enhance the beneficial result while causing the least amount of extra adverse effects. According to the current database, there is a dearth of research on the impact of nalbuphine as a complement to local anaesthetics in peripheral nerve blocks.

The primary aim of this research was to assess the effect of Nalbuphine as an adjuvant with Ropivacaine on supraclavicular block and the duration of analgesia (DOA). The secondary aim was to document the onset, duration and occurrence of motor and sensory block as well as any adverse events.

MATERIALS AND METHODS

This study was carried out in a tertiary care center of northern India after getting an approval from the institutional Ethics committee. This study was conducted from December 2022 till October 2023.

Inclusion Criteria: Patients from both sexes in the age group of 20-60 years, having physical status corresponding to American Society of Anesthesiologists classification (ASA) I and II and weight between 50-70 kg were included in the study.

Exclusion criteria: Patient refusal, coagulopathy, ASA III and above were the exclusion criteria. Those with severe cardiovascular, pulmonary, kidney, liver disease, neurological, psychiatric, neuromuscular disorder, infection/sepsis/allergy, pneumothorax, and peripheral neuropathy were excluded from the study.

Seventy patients posted for mid humerus, elbow, forearm and hand surgeries were chosen for the study. They were divided into 2 groups randomly with help of chit and box method. Patients in both groups received supraclavicular brachial plexus block under real-time Ultrasonographic (USG) guidance. The two groups were – a) Group R (n = 35) who received 29 mL of 0.75% Inj. Ropivacaine + 1 mL Normal Saline and b) Group N (n = 35) who received 29 mL of 0.75% Inj. Ropivacaine + 1 mL (10 mg) Nalbuphine.

Prior to surgery, all patients underwent evaluations and examinations, and their informed consent was acquired. Upon entering the preoperative area, a contralateral upper limb peripheral vein was used to insert a 20G intravenous (IV) cannula. Before being sent to the operating room, the patient was given a second explanation of the entire process. Standard monitoring techniques such as electrocardiography (ECG), non-invasive blood pressure (NIBP), and pulse oximetry (SpO2) were also used. Pre-block measurements were baseline heart rate (HR), blood pressure (BP), oxygen saturation and respiratory rate.

An experienced anesthesiologist performed brachial plexus block on all patients using the supraclavicular technique and real-time USG guidance (using a system called The Sonosite MicromaxxTM (Bothell, Washington, USA) with a linear probe that ranges from 6 to 13 MHz. A 21G 50 mm short beveled insulated needle was inserted under USG guidance with all aseptic precautions and the local anesthetic solution was injected after careful aspiration when the needle tip came adjacent to the plexus. According to the group allocated, a predetermined volume of 30 ml of the drug solution was administered under ultrasound imaging. This being a double-blind trial, neither the administrator nor the observer was aware of the identity of the drug as it was prepared by a different investigator. The administered drug was to be revealed only upon occurrence of any adverse effect.

Following the local anaesthetic injection, the patient's motor and sensory blockage was evaluated and compared to the contralateral side. The pin prick method was used to measure sensory block on a 3-point scale [Table 1]. Until total sensory blockade was established, the sensory block was evaluated in the dermatomes corresponding to the median, radial, ulnar, and musculocutaneous nerves (C5-T1).

Outcome Definitions

When all dermatomes innervated by the brachial plexus (C5–T1) were blocked after 30 minutes, the supraclavicular block was deemed effective. Using the contralateral limb as a reference, the lack of

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pinprick sensation was used to characterize the onset of sensory block. For the first thirty minutes following surgery, it was assessed every two minutes, and then every sixty minutes until the sensory block totally subsided. The amount of time between the injection of local anesthetic till there was total absence of pain in all dermatomes innervated by the brachial plexus was determined to be the duration of sensory block.

The modified Bromage scale was used to assess motor block,[9] done every 3 minutes till the establishment of complete motor blockade. The time elapsed between the end of injection of the local anaesthetic (LA) to the development of Grade 3 motor block was defined as the onset of motor block [Table 2]. The time interval between the end of LA administration to the recovery of complete motor function of the hand and forearm was defined as the duration of motor block.

Those patients whose block was ineffective or incomplete were excluded from the study, and surgery was done under general anesthesia.

The quality of analgesia was assessed every hour postoperatively in the recovery room and in the surgical ward by attending nurse using Numeric Pain Rating Scale (NPRS) (1–10).[10] Zero was considered as no pain, 1–3 as mild pain, 4–6 as moderate pain and 7–10 as severe pain. At the score of 4, nursing staff was directed to administer rescue analgesia, namely, Inj. Diclofenac sodium (1.5 mg/kg) intramuscularly. Duration of analgesia was defined as the time from local anaesthetic injection to the time of first analgesic requirement (rescue analgesia). During the intra- and post-operative phases, all patients were monitored for any adverse reactions, including nausea, vomiting, pneumothorax, hematoma, and LA toxicity.

With 75 patients enrolled and considering potential dropouts, the sample size was determined to be at least 35 patients in each group when α error = 0.05, power = 80%, and effect size d = 0.8, taking into account two tailed significance. The mean and standard deviation of the data were displayed. The mean and standard deviation (SD) of the onset time, the length of the sensory and motor blocks, the length of the surgery, the total amount of time the analgesia was caused by the brachial plexus block, and the hemodynamic variables (heart rate, diastolic blood pressure, diastolic blood pressure, and mean arterial pressure) were all analysed statistically using the t-test. The student's t-test was used to analyse the demographic data (age and weight). Mann-Whitney U-tests were used to compare NPRS scores between groups in a non-parametric manner. A P-value of less than 0.05 was considered statistically significant. Version 21.0 of the Statistical Package for Social Science (SPSS) software was used for all statistical analysis. (SPSS Inc., USA, Chicago, IL)

RESULTS

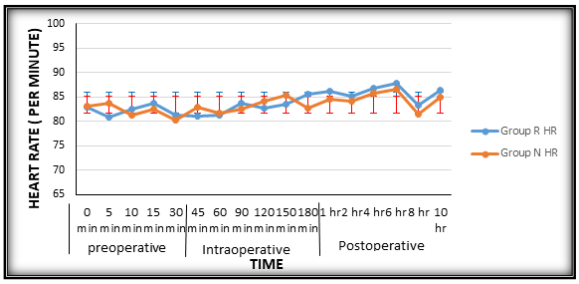
75 patients were assessed for eligibility. There is a consort diagram in [Figure 1]. In both groups, the patient demographics (age, sex, weight, and ASA grades) were similar [Table 3].

In both groups, the mean onsets of motor and sensory block were not statistically significant [Table 4].

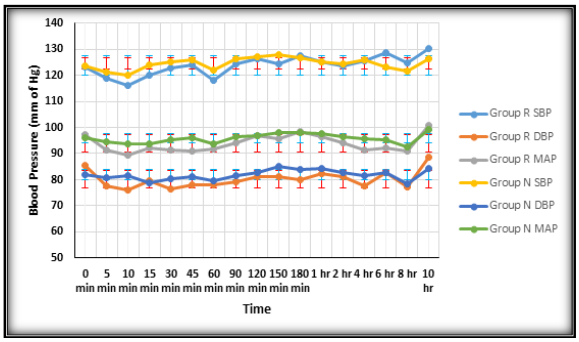
Group R experienced considerably longer mean durations of sensory and motor blocks than Group N ($P < 0.0001$) [Table 4].

The statistical significance ($P < 0.0001$) was seen in the mean duration of analgesia, which was 605.45±17.42 minutes in Group R and 719.12±29.21 minutes in Group N [Table 4].

At every stage of the procedure, there was no discernible variation in the hemodynamic parameters between the two groups [Graphs 1 and 2].



Graph 1: Perioperative comparison heart rate in both the groups.



Graph 2: Perioperative comparison of systolic blood pressure, diastolic blood pressure and mean arterial pressure (mm of Hg) in both groups.

Table 1: Sensory Blockade with 3-point pin prick method.

Grade	Sensory Blockade
0	No Pain
1	Blunt Pain
2	Sharp Pain

Table 2: Motor Blockade as per modified Bromage scale

Grade	Motor Blockade
0	Normal motor function, able to raise the extended arm to 90°

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1	Able to flex the elbow and move the fingers but unable to raise the extended arm.
2	Unable to flex the elbow but able to move the fingers;
3	Complete motor block

Table 3: Demographic profile, ASA grading and Duration of Surgery

Parameters	Group R	Group N	P Value
Age (Years)	31.24±8.49	30.34±11.24	0.71
Weight (Kg)	55.84±9.82	54.24±10.43	0.51
Gender (M/F)	21/14	24/11	0.45
ASA (I/II)	25/10	21/14	0.31
Duration of Surgery (minutes)	130.12±14.44	132.64±11.23	0.42
P Value < 0.05 (Significant)			

Table 4: Onset, duration of sensory and motor blocks, duration of analgesia and Rescue Analgesia in Group R and Group N

	Group R	Group N	P Value
Sensory onset (minutes)	11.51±3.66	11.01±3.11	0.54
Motor onset (minutes)	13.1±4.92	11.23±3.34	0.07
Sensory duration (minutes)	520.12±13.42	580.13±17.23	0.0001
Motor duration (minutes)	456.43±15.22	512.23±16.34	0.0001
Duration of Analgesia (minutes)	605.45±17.42	719.12±29.21	0.0001
P Value < 0.05 (Significant)			

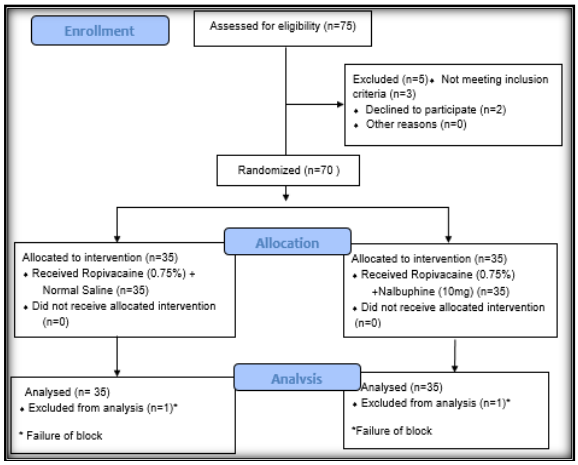

Figure 1: CONSORT Flow Diagram

DISCUSSION

Supraclavicular brachial plexus block provides a rapid, dense, and predictable anesthesia of the entire upper extremity.[11] It provides an excellent alternative technique to general anesthesia for the upper limb surgical procedures. It offers excellent intraoperative pain relief as well as good post-operative analgesia which is vital to limit the duration of stay in the hospital. Local anesthetics, when used as the sole anesthetic agent for such blocks, provide a duration of analgesia which is insufficient to effectively address the patients' analgesic requirement in the post-operative period. Thus, arose the quest for an effective adjuvant which could prolong the block duration without being overtly expensive or difficult to obtain and would have insignificant side effects. The combination of local anesthetic and the adjuvant promise dual advantage. The chances of systemic toxicity with high concentrations of local anesthetic agents would decrease and the duration of block would be much longer, augmenting the post-operative analgesia.[12]

Nalbuphine hydrochloride, a 14-hydroxymorphine derivative, is a potent analgesic which acts as a Kappa agonist and partial mu antagonist. Its affinity to κ-opioid receptors results in sedation, analgesia, and cardiovascular stability with minimal respiratory depression because of ceiling effect.[13-15] According to a meta-analysis,[14] nalbuphine and morphine both provide excellent pain relief, but nalbuphine has far lower rates of pruritus, nausea, vomiting, and respiratory depression than morphine.

The dose of Nalbuphine chosen for the purpose of this study was 10 mg as it has been used in same dose in previous studies without any significant side effect or any neuro toxicity while providing good analgesia.[16,17]

In this investigation, 29 ml of 0.75% ropivacaine were employed, and this resulted in total sensory and motor block with no adverse effects. This amount and concentration are sufficient, as evidenced by the findings, which are consistent with earlier research. Previous experiments have effectively used concentrations of both 0.5% and 0.75%.[12-14]

In both groups in this investigation, there was no statistically significant difference in the onset of sensory or motor block. The mean onset of motor block was identical in both groups (13.1±4.92 min in Group R versus 11.23±3.34 min in Group N), so was the mean onset of sensory block (11.51±3.66min in Group R versus 11.01±3.11 in Group N). Das A et al. saw similar results when levobupivacaine was taken alone and in combination with nalbuphine.[15]

In this study, the duration of sensory block (520.12 ±13.42 min in Group R vs. 580.13±17.23 min in Group N) was significantly prolonged in the Nalbuphine group as compared to the control group which had received Normal Saline. Similarly, the duration of motor block (456.43±15.22 min in R Group vs. 512.23±16.34 min in N Group) was also significantly prolonged in the Nalbuphine group than that in the control group.

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In our study the duration of analgesia was significantly higher in Group N (719.12±29.21 min) compared to Group R (605.45±17.42 min) which may be because of synergistic action of Nalbuphine with Ropivacaine.

Though sample size used in the study is statistically appropriate, still larger sample size with high power will reinforce our findings.

CONCLUSION

In light of the observations as mentioned above, it can be concluded that Nalbuphine 10mg when used in conjunction with Inj. 0.75%Ropivacaine in supraclavicular brachial plexus block results in prolongation of the sensory and motor blockade, although it does not quicken the onset time of either. Additionally, it does not cause any further adverse effects in the postoperative period. Hence, it is safe to say that Nalbuphine, when not contraindicated, can be valuable as an adjuvant to prolong the effect of supraclavicular brachial plexus blockade.

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