Original Article

Effect of buprenorphine as an adjunct with plain local anesthetic solution in supraclavicular brachial plexus block on quality and duration of postoperative analgesia

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Abstract

Background and Aims: Supraclavicular brachial plexus block is ideal for upper limb surgical procedures. Buprenorphine, an agonist antagonist opioid has been used as an adjunct to prolong analgesia. We aimed to evaluate the quality and duration of postoperative analgesia by addition of buprenorphine to local anesthetic solution.

Material and Methods: A prospective, randomized, double-blind control study was conducted on 50 healthy patients of ASA Grade I/II of age group 20-70 years scheduled for orthopedic and reconstructive surgery of upper limb under supraclavicular brachial plexus block. Patients were allocated into two groups, 25 in each group viz.: Group B (buprenorphine group) received 20 ml 0.5% bupivacaine + 15 ml 2% lignocaine with adrenaline (1:200,000) + 4 ml normal saline + 1500 units hyaluronidase + 3 μg/kg buprenorphine diluted to 1 ml normal saline. Group C (control group) received 20 ml 0.5% bupivacaine + 15 ml 2% lignocaine with adrenaline (1:200,000) + 4 ml normal saline + 1500 units hyaluronidase + 1 ml normal saline. The parameters observed were onset and duration of sensory and motor block, quality and duration of analgesia and side-effects.

Results: The mean duration of postoperative analgesia was significantly longer in Group B (16.04 ± 3.19 h) than in Group C (6.20 ± 0.74 h). There was no difference between two groups on mean onset of sensory block. The mean duration motor block was significantly longer in Group B (4.93 ± 0.94 h) than in Group C (2.25 ± 0.62 h) [$P < 0.05$]. The mean duration of sensory block was also significantly longer in Group B (5.71 ± 0.94 h) than in Group C (4.94 ± 0.70 h) with $P < 0.05$.

Conclusion: Addition of 3 μg/kg buprenorphine to 0.5% bupivacaine for supraclavicular brachial plexus block prolonged duration of postoperative analgesia and sensory blockade without an increase in side effects.

Key words: Bupivacaine, buprenorphine, local anesthetics, postoperative analgesia, supraclavicular brachial plexus block

Introduction

Supraclavicular approach to brachial plexus block is routinely used all over the world for surgeries of upper limb because of the anatomical ease of blocking nerve roots at this level of brachial plexus.[1,2]

Over many years many adjuvant drugs like vasoconstrictor adrenaline have been tried with local anesthetics to prolong intraoperative anesthesia and postoperative analgesia.[5] Peripheral opioid administration improves regional anesthesia without centrally mediated side effects.

We evaluated the hypothesis that the addition of buprenorphine in supraclavicular block will enhance postoperative analgesia. Buprenorphine is lipophilic opioid with high molecular weight and having high affinity for μ receptors, has a longer duration of action,[3,4] easily available, cost-effective and hence selected for this study.

Material and Methods

After approval from the Hospital Ethics Committee a prospective, double-blind randomized study was conducted on 50 adult patients of ASA Grade I/II in the age group 20-70 years having body weight 40-70 kg, posted for various upper limb surgery under supraclavicular brachial plexus block. Orthopedic, plastic surgery and general surgical procedures were included in this study.

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Non-consenting patients, patients with peripheral neuropathy, coagulation disorders, known allergy to local anesthetic solution, local infection at site of injection, history of seizures were excluded from the study. After satisfying inclusion and exclusion criteria, a thorough preoperative evaluation was performed. The patient was briefed about the supraclavicular block to be performed, its advantages over general anesthesia (GA) and also about the associated complications. Informed consent was obtained from every patient prior to the study, and they were familiarized with the use of Visual Analog Scale (VAS) scoring system. Sensitivity testing was done for lignocaine in all patients, and the patients were kept fasting 6 hours prior to surgery.

Patients were randomly allocated into two groups. Randomization was done by allocating random number generated by the computer to each patient with each group consisting of 25 patients.

Group B (buprenorphine group) received 20 ml 0.5% bupivacaine + 15 ml 2% lignocaine with adrenaline (1:200,000) + 4 ml normal saline + 1500 units hyaluronidase + 3 μg/kg buprenorphine diluted to 1 ml normal saline.

Group C (control group) received 20 ml 0.5% bupivacaine + 15 ml 2% lignocaine with adrenaline (1:200,000) + 4 ml normal saline + 1500 units hyaluronidase + 1 ml normal saline.

The investigator, attending anesthesiologist "Y" and patients were unaware of the nature of group and drug allocation.

The study drug was prepared by "X" anesthetist not involved in performing the block, patient care or in data collection. Supraclavicular block, intraoperative and postoperative monitoring was done by "Y" anesthetist. At the end of the study decoding of data was done. In our study, only those with zero effect were excluded.

Baseline (before start of procedure) pulse, blood pressure (BP), respiratory rate, peripheral oxygen saturation (SpO_2) were recorded. Patient was positioned in supine position and arm to be blocked adducted and kept by the side. Head was turned to opposite side. Intravenous (IV) access was secured with 20G Teflon Cannula and IV fluid Ringer's lactate was started. Monitors were attached before performing the procedure for continuous recording of noninvasive BP, heart rate, electrocardiogram and SpO_2. All patients included in the study received injection glycopyrrolate 0.2 mg IV and injection ondansetron 4 mg IV as premedication.

After sterile preparation of the region supraclavicular block was performed by the "Classic Approach," which was first described by Kulenkampff[5] in 1911. In the initial few cases, the brachial plexus was located with the aid of a nerve stimulator, but due to technical snags, it could not be used further. So fresh cases were done by paresthesia method and walking on the first rib technique. 22G 1 inch hypodermic needle was used to perform the block. Oxygen was administered at rate of 3-5 L/min with face mask.

Vital parameters (pulse, respirations, BP) were monitored every 2 min for 30 min and then every ½ h till 8 h and then every 1 h till patient complaints of pain equivalent to VAS score of 4. The following parameters were noted — duration of surgery, tourniquet time, onset of sensory block, onset of motor block, attainment of complete sensory block, attainment of complete motor block, duration of sensory and motor block, duration of postoperative analgesia and supplementation with sedation/GA.

Onset time

Sensory block

Time between injection and loss of pin prick sensation in one particular nerve distribution, pin prick test done with sterile 25G needle.

Motor block

Time between injection and loss of flexion or extension movement in hand or arm against gravity.

Sensory and motor blocks were assessed every 2 min for 30 min and there after every ½ h up to 8 h.

Quality of sensory block was graded as:

- 0: Sharp pain, that is, pin prick with 25G needle felt.
- 1: Only touch felt, but not pin prick.
- 2: Not even touch sensation appreciated.

Quality of motor block was graded as:

- 0: No movement at all of the upper limb against gravity.
- 1: Flexion and/or extension movement in the hand but not in the arm.
- 2: Flexion and/or extension movement in both hands and arms against gravity; not against resistance.
- 3: Flexion and extension movement in both the hands and arms against the resistance.

Motor block was assessed by the same observer at the same time intervals by ability to perform specific movements, as stated above.

Attainment of complete sensory block

Time in minutes after drug injection to reach the maximum grade of sensory block (Grade 2).

Attainment of complete motor block

Time in minutes after drug injection to attain the maximum grade of motor block (Grade 3).

Duration of sensory block

Time from the onset of sensory block to return of complete sensation, that is, sensory Grade 0 attained.

Duration of motor block

Time from the onset of motor block to restoration of full hand and wrist mobility. That is, Motor Grade 0 attained.

Duration of analgesia

Time between supraclavicular brachial plexus block administration and onset of pain that is, VAS ≥4.

Visual analogue scale

On a scale of 0-10, the patient was asked to quantify postoperative pain.

0: No pain, 10: Maximum/worst imaginable pain.

Visual Analog Scale assessment was done every 2 min for first 30 min. Then half hourly for first 8 h then every 1 hourly till patient complained of pain equivalent to a VAS score of 4.

Pain was assessed by VAS score by "Y" anesthetist who conducted the block. Rescue analgesia (injection diclofenac 75 mg IV) was administered when VAS score reached 4. If the pain is not relieved, rescue analgesia is given again in the form of IV paracetamol injection. After the end of study decoding of data were done, and patient belonging to Groups B and C was identified.

Statistical analysis

The onset of sensory block, motor block, and duration of analgesia were compared using analysis of variance. Further analysis was performed using paired *t*-test. Chi-square test was used for analysis of nonparametric data. $P < 0.05$ was considered as statistically significant.

Results

Both the groups were similar with regards to age, sex ratio, weight and duration and type of surgery [Table 1]. The mean onset of sensory block between two groups were not statistically significant. It was (2.64 ± 2.12 min) in Group B versus (2.52 ± 1.35 min) in Group C with $P > 0.05$.

The mean onset of motor block was faster in Group B (2.64 ± 5.70 min) than Group C (4.48 ± 2.10 min) [Table 2].

The mean duration of motor block was more in Group B (4.93 ± 0.94 h) than Group C (2.25 ± 0.62 h) with $P < 0.05$ which was statistically significant.

The mean duration of sensory block was significantly longer in Group B (5.71 ± 0.94 h) than in Group C (4.94 ± 0.70 h).

The duration of analgesia (i.e., onset of block to perception of pain) was much longer in Group B (16.04 ± 3.19 h) than in Group C (6.20 ± 0.74 h) with $P < 0.05$. In Group B 14 (56%) patients had duration of analgesia lasting for about 15.1-20 h, whereas in Group C 12 (48%) patients had duration of analgesia lasting for about 6.1-7 h.

The onset of pain was much earlier in Group C, that is, mean VAS score was 4 at 8th postoperative hour where as it was only 1.27 ± 0.61 at 8th postoperative hour in Group B. Group B has mean VAS score of 4 at 24th h postoperatively [Figure 1].

Vitals parameters like mean respiratory rate and mean O_2 saturation value were similar in both groups and did not show any significant difference. Patients in control group (Group C) demonstrated a steady gradual rise in BP and Pulse rate from

Table 1: Comparison of demographic parameters and duration of surgery

Parameter	Group B (mean ± SD)	Group C (mean ± SD)	*P*
Age (years)	36.52±16.07	33.76±12.67	0.5035
Weight (kg)	54.64±5.47	58.24±8.60	0.0975
Male:female	20:5	18:7	0.5692
Duration of surgery (h)	2.12±1.04	1.65±0.65	0.0560

SD = Standard deviation

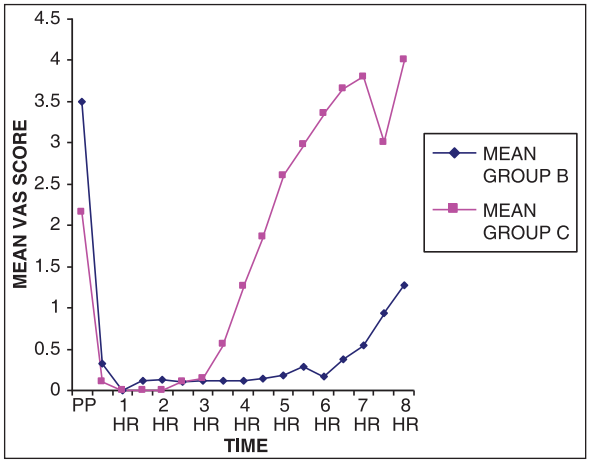

Figure 1: Comparison of mean values of visual analogue scale of Group B and C

4.5 to 5 h postoperatively, while as patients in buprenorphine group (Group B) showed much delayed rise in pulse rate and BP from 13th to 14th h postoperatively.

The supplementation of block with sedation was more in control Group C (5 cases i.e., 20%) as compared to buprenorphine Group B (3 cases i.e., 12%).

In our study group two patients out of 25 (8%) complained of nausea and another two patients (8%) complained of vomiting where as in control group only 1 (4%) complained of nausea and 1 (4%) patient complained of vomiting. None in either group had complained of pruritus, urinary retention or had any evidence of respiratory depression or pneumothorax or neurological sequelae [Table 3].

Discussion

Our study demonstrated statistically significant longer duration of sensory and motor block contributing to longer and good quality postoperative analgesia in subjects receiving buprenorphine as adjuncts to local anesthetic solution. Orthopedic and plastic reconstructive surgeries can predictably be of prolonged duration. Thus prolonged sensory, and motor blockade along with prolonged analgesia are of utmost importance in these surgeries.

Table 2: Comparison of block characteristics in Groups B and C

Variable	Mean ± SD (Group B)	Mean ± SD (Group C)	*P*
Onset of sensory block (min)	2.64±2.12	2.52±1.36	0.813
On set of motor block (min)	2.64±5.70	4.08±2.10	0.453
Complete sensory block (min)	7.76±3.05	8.24±2.30	0.523
Complete motor block (min)	13.00±6.49	12.52±4.57	0.741
Quality of sensory block	2.00±0.00	2.00±0.00	0.348
Quality of motor block	2.88±0.33	2.92±0.28	0.564
Duration of sensory block (h)	5.70±0.94	4.94±0.70	0.01
Duration of motor block (h)	4.93±0.93	2.52±0.62	0.01
Duration of analgesia	16.04±3.19	6.20±0.74	0.00
Numerical rating (VAS) at 8 h	1.58±0.72	4.00	0.01

$P < 0.05$ = Statistically significant, SD = Standard deviation, VAS = Visual analogue scale

Table 3: Frequency distribution of adverse drug side-effect of Group B and C

Side-effect	Frequencies		Percentage		*P*
	Group B	Group C	Group B	Group C	
Nil	21	23	84	92	0.6141
Nausea	2	1	8	4	
Vomiting	2	1	8	4	
Pruritus	0	0	0	0	
Others	0	0	0	0	
Total	25	25	100	100	

Opioids are routinely added to local anesthetics in supraclavicular brachial plexus blockade to prolong the duration of postoperative analgesic effect.[6-12] Due to easy availability, cost effectiveness, lack of significant side-effects like respiratory depression and sedation, longer duration of action,[7] lipophilic nature, high affinity for μ receptor, buprenorphine has been selected for study as an adjuvant for study in brachial plexus block. Many studies evaluated effect of buprenorphine when added to local anesthetic for brachial plexus block and concluded that it prolongs postoperative analgesia.[8,11,12]

Buprenorphine, an opioid has nonspecific local anesthetic effect. It decreases K^+ ion conduction and increases Ca^{++} ion conduction in the cell body of neurons, which reduces excitability of nociceptive neurons and accentuate the prolongation of action potential. It inhibits release of excitatory neurotransmitter substance P from peripheral sensory nerve ending. Peripheral administration of opioids also has central action caused by centripetal movement of opioids binding to opioid binding proteins from periphery to dorsal horn.[9,10] The duration of analgesia was twice as long in buprenorphine as in morphine group.[11]

In our study, time for onset of sensory block and motor block was not statistically significant in both the groups. Similar results were observed by Racz *et al.*[13] who did not elicit any difference in onset, time for complete effect of block using perineural morphine with bupivacaine and lignocaine. Nishikawa *et al.*[14] found that the addition of fentanyl improved success rate of sensory block but delayed the onset of analgesia due to decrease in pH.

Many researchers have observed similar prolongation of duration in sensory and motor block similar to the results of our study.[8,11,12,15,16]

The mean duration of satisfactory analgesia and higher VAS score observed in our study are in consonace with the results of Jadon *et al.*[17]

Thus our study demonstrated statistically significant longer duration of sensory and motor block contributing to longer and satisfactory quality of postoperative analgesia in subjects receiving buprenorphine as adjuncts to local anesthetic solution.

Conclusion

Buprenorphine added to local anesthetic solution in supraclavicular brachial plexus block in dose of 3 μg/kg provides excellent postoperative analgesia lasting almost 2.5 times longer than local anesthetic solution alone.

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