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**Original Research Article**

# Evaluation of buprenorphine as an adjuvant to 2% lidocaine during intravenous regional anaesthesia

**Yashoda Venkappa[1], Sanchara M. Paramesh[2]*, Champa Banavara Venkatesha Murthy[1], Geetanjali Masamaddi[3]**

[1]Department of Anaesthesiology, Shimoga Institute of Medical Sciences, Shimoga, Karnataka, India
[2]Department of Anaesthesiology, Mysore Medical college and Research Institute; Mysore, Karnataka, India
[3]Department of Anaesthesiology, BGS Global Institute of Medical Sciences, Kengeri, Bangalore, Karnataka, India

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***Correspondence:**
Dr. Sanchara M. Paramesh,
E-mail: sanchara93@gmail.com



## ABSTRACT

**Background:** Intravenous regional anaesthesia (IVRA) is a simple, effective method of anaesthesia for surgical procedures on the extremities. Major limitations are tourniquet pain, short duration of block and absence of post-operative analgesia. Buprenorphine is known to improve the quality of anaesthesia. Aim of this study is to evaluate the efficacy of buprenorphine as an adjuvant to lignocaine in IVRA.
**Methods:** Sixty patients between 18-60 years age, belonging to the ASA grade 1, 2 undergoing upper limb surgeries were enrolled into the study. Patients belonging to group BL patients received 10 ml of preservative free lidocaine 2% diluted to 40 ml. Group BB-patients received 10 ml of preservative free lidocaine 2% mixed with 60 mcg of buprenorphine diluted to 40 ml. Onset of sensory and motor block; recovery time and postoperative analgesia were noted. Data were analyzed using chi-square test, independent 't' test.
**Results:** The onset time of both sensory and motor block were significantly shortened, the recovery of sensory and motor block was prolonged, the incidence of tourniquet pain was comparatively lesser and there was significantly increased duration of post-operative analgesia in the buprenorphine group. Haemo-dynamic parameters were similar in both groups
**Conclusions:** Sixty mcg buprenorphine as an adjuvant to lidocaine in IVRA effectively enhances the anaesthesia and post-operative analgesia.

**Keywords:** Bier's block, Buprenorphine, Lidocaine, Tourniquet pain

## INTRODUCTION

August Gustav Bier in 1908 described Intravenous regional anesthesia (IVRA)for anesthesia of hand and forearm.[1] Though it was described earlier it achieved widespread popularity only in 1963 after Holmes introduced the use of lignocaine in IVRA.[2] This has success rates between 94% to 98% and most safe, reliable, cost effective and simple technique; providing anaesthesia as well as bloodless field for upper limb surgery.[3,4] IVRA is ideal for short operative procedure of extremities lasting for less than a hour done on ambulatory basis.[1] It also offers reduced nursing time in the postoperative period, early hospital discharge and decreased hospital costs.[5] The principle applied in this technique is isolating the distal limb from systemic circulation by applying pressure to proximal limb by using pneumatic tourniquet.[1,3] Following which local anaesthetic is injected to isolated limb producing rapid onset of analgesia.[1] The site of action IVRA solution is small nerves or nerve endings.[4] The ideal IVRA solution should have -rapid onset of action , reducing dose of local anesthetic and tourniquet pain; prolonged postdeflation

analgesia.[6] A variety of opioids like fentanyl, sulfentanil, morphine, mepridine, buprenorphine and tramadol have been tried to improve perioperative analgesia.[1] Among opioids, buprenorphine potentially blocked multiple isolated voltage gated alphasubunits of sodium channels via the local anesthetic binding sites in contrast to other μ-opioid receptor agonists making it relevant when used for pain treatment and for local anesthesia.[1] Very few studies have used Buprenorphine as an additive to lignocaine. So, this study is conducted to study the effect of buprenorphine as an adjuvant to lignocaine IVRA.

Disadvantages of Bier's block include the potential for local anaesthetic toxicity, slow onset, emergence of pain following removal of the bandage (within three to five minutes), tourniquet pain, poor muscle relaxation and lack of postoperative analgesia.[7,8]

### *Aims and objectives*

Aim and objectives were to evaluate anaesthetic and postoperative analgesic efficacy of buprenorphine 60 mcg when administered as an adjuvant to 0.5% lidocaine in IVRA.

## METHODS

Study was conducted after obtaining institutional ethical committee clearance [IEC recognised by CDSCO vide Regn. No. ECR/952/Inst/KA/2017 and our study details-SIMS/IEC/392/2017-18 on 08/05/2018] and patients consent. Study design-Prospective randomized double blinded comparative clinical Study. Duration of study-November 2018 to December 2020. Source of data-the department of anesthesiology at McGann hospital, Shimoga institute of medical sciences, Shimoga. Sample size-30 patients in each group. ASA physical status I and II patients aged between 18-65 years, of either sex, scheduled for hand or forearm surgery were included in the study. Following patients were excluded from the study: history of allergy to the drugs used in the study; patients with sickle cell anemia; patients with bleeding and coagulation disorders; patients with Raynaud's disease, scleroderma, myasthenia gravis, liver or renal insufficiency, diabetes mellitus, thrombocytopenia, history of convulsions, asthma or cardiac disease; pregnant and lactating mothers. Pre-anesthetic check-up was done a day before surgery and included a detailed history, complete physical and systemic examination and relevant investigations. Informed written consent was taken for each patient and patient was kept 8 hours fasting overnight before surgery. Intradermal test for lidocaine sensitivity was done in all patients. The patients were divided randomly into two groups of 30 each. Group BL-Patients in this group received 10 ml of preservative free lidocaine 2% diluted with saline, to a total volume of 40 ml. Group BB-Patients in this group received 10 ml of preservative free lidocaine 2% mixed with 60 mcg of buprenorphine diluted with saline, to a total volume of 40 ml.

After application of routine monitors, a double tourniquet was positioned on the upper operative arm. Standard ASA monitoring was used in all patients, which included noninvasive arterial blood pressure, heart rate, electrocardiogram and pulse oximetry. Two cannulas were placed: one in a vein on the dorsum of the operative hand and the other in the opposite hand for crystalloid infusion.

The upper limb was elevated and wrapped with an Esmarch bandage for exsanguinations. A proximal and a distal tourniquet was placed over cotton pad. Circulatory isolation of the arm was verified by inspection, absence of a radial pulse, and a loss of the pulse oximetry tracing in the ipsilateral index finger.

Anesthetic solutions were administered by an anesthetist blinded to the study. Prior to administration of IVRA, an infusion of 0.9% normal saline was started in the normal limb. After confirming that both sensory and motor anaesthesia had been achieved, the distal tourniquet cuff was inflated to 250 mmHg, and the proximal tourniquet cuff was released, then the surgery was commenced.

Sensory blockade was assessed by blunt bevel pinprick at six areas, representing smaller branches of four peripheral nerves i.e., lateral aspect of forearm for musculocutaneous nerve; dorsal 1st web space for radial nerve; index fingertip and thenar eminence for median nerve; and little fingertip and hypothenar eminence for ulnar nerve. Sensory block onset time was noted as the time elapsed from injection of drug to sensory block achieved in all dermatomes. Characteristics of sensory block was assessed at interval of 1 minute till complete block. The sensory block was assessed by the response to pinprick using a score scale of 0-2. 0-normal sensation, 1-loss of sensation to pinprick (analgesia), 2-loss of sensation to touch (anaesthesia).

Characteristics of motor block was assessed at an interval of 2 minutes according to modified Bromage scale, with a score scale 0-2 for the following actions- thumb abduction (radial nerve), thumb adduction (ulnar nerve) thumb opposition (median nerve) flexion of elbow (musculocutaneous nerve). 0-normal motor function with full flexion, extension of elbow, wrist and fingers, 1-Decreased motor strength with ability to move fingers only, 2-Complete motor block with inability to move fingers

HR, MAP and $SpO_2$ were recorded during the procedure and there was no difference between groups. Intra-operative degree of analgesia was evaluated by visual analogue scale (VAS) of 0-10 (0-No pain, 10-Worst pain).

Time of onset of tourniquet pain was recorded and assessed based on VAS scale (0 no pain and 10 worst pain imaginable). When patients complained of pain at the tourniquet site with VAS >3, the proximal tourniquet

was deflated. The distal tourniquet was eventually released if the previous maneuver did not achieve pain relief and boluses of fentanyl 1 µg/kg were administered for tourniquet pain. Total fentanyl usage was recorded. The tourniquet was not deflated before 30 min and was not inflated for 2 h. At the end of surgery, the tourniquet was deflated by a cyclic deflation technique.

Assessment of the postoperative pain was done on linear VAS from 0 (no pain) to 10 (unbearable pain) Postoperatively patients were given IM diclofenac 1.5 mg/kg when VAS>3 and the time at which the analgesic was given was recorded, and the duration of analgesia was noted as time from deflation of tourniquet up to injection of diclofenac (first rescue analgesia).

Sensory block recovery time was noted as the time elapsed from release of tourniquet to perception of pain in all dermatomes determined by pin-prick test.[4]

Motor block recovery time was noted as the time elapsed from release of tourniquet to ability to move arm against resistance.[1]

Hypotension defined as a 25% decrease from baseline and was treated with IV ephedrine 3-6 mg bolus. Bradycardia, defined as a 25% decrease from baseline was treated with IV atropine 0.5 mg. Arterial oxygen saturation less than 91% on room air was treated with 02 supplemented via face mask. During the study period any other complications such as dry mouth, nausea/vomiting or respiratory depression were noted.

***Statistical analysis***[9,10,11]

Chi- square test was used as test of significance for categorical data. Continuous data was represented as mean and standard deviation and independent t test was used as test of significance. P<0.05 was considered as statistically significant after assuming all rules of statistical tests. Statistical software-SPSS version 22.0 was used to analyze data.

## RESULTS

In our study, the demographic data of the groups were comparable for mean age, sex ratio. There was also no difference between the groups when compared for mean arterial pressure, heart rate and oxygen saturation ($SpO_2$) during intra and postoperative period.

The time of onset for sensory block was shorter in group BB (SD-18.9 secs) as compared to group BL (17.2 secs) (p<0.001) and is statistically significant. The onset of motor block was earlier in group BB (SD-16.3) compared to group BL (SD-19.8) p<0.001 and is statistically significant. The recovery time of both sensory and motor block was earlier in group BL compared to group BB with p<0.001. In all patients, in group BB mean analgesic duration was 7.1±0.5 hours whereas in group BL analgesic duration did not last for more than 1.5-2 hours (1.5±0.5 hours). VAS scores were significantly lower in group BB as compared to BL (p<0.001).

**Table1: Age categories by groups.**

| Age category (years) | Lignocaine + Buprenorphine, N (%) | Lignocaine, N (%) | P value |
|---|---|---|---|
| **18 to 25** | 6 (20) | 9 (30) | 0.47 |
| **26 to 35** | 9 (30) | 8 (26.7) | |
| **36 to 45** | 10 (33.3) | 6 (20.0) | |
| **46 to 54** | 5 (16.7) | 7 (23.3) | |
| **Mean (SD)** | 35.8 (10.2) | 33.8 (11.1) | |
| **Total** | 30 (100) | 30 (100) | |

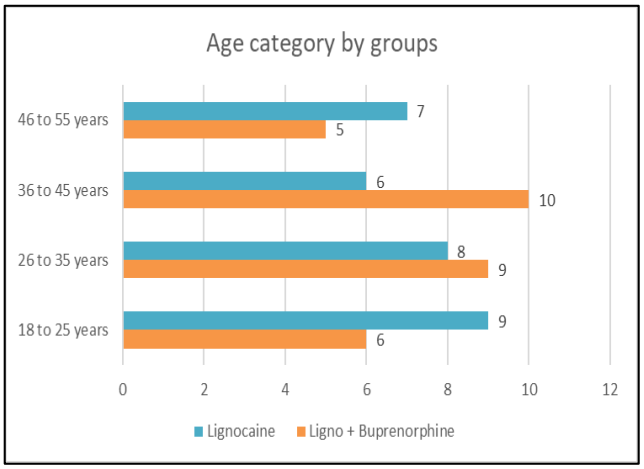


**Figure 1: Age distribution among groups.**

**Table 2: Sex categories by groups.**

| Sex category | Lignocaine + buprenorphine, N (%) | Lignocaine, N (%) | P value |
|---|---|---|---|
| **Male** | 15 (50) | 15 (50) | 0.6 |
| **Female** | 15 (50) | 15 (50) | |
| **Total** | 30 (100) | 30 (100) | |

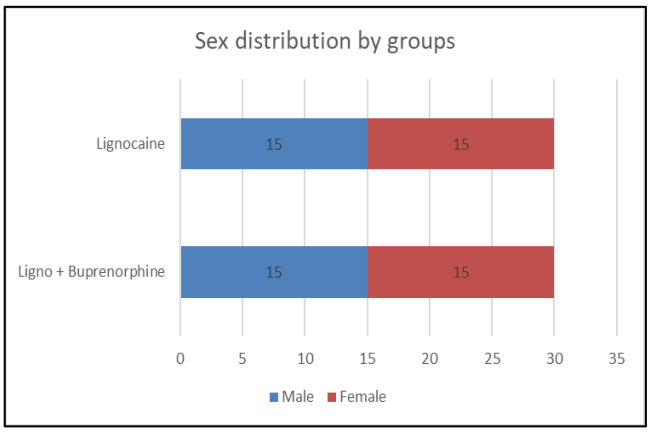


**Figure 2: Sex distribution among groups.**

**Table 3: Onset time of sensory and motor among groups.**

| Variables | Lignocaine + buprenorphine, mean (SD) | Lignocaine, mean (SD) | P value |
|---|---|---|---|
| **Sensory (secs)** | 223.5 (18.9) | 376.1 (17.2) | <0.001 |
| **Motor (secs)** | 489.3 (16.3) | 561.2 (19.8) | <0.001 |

There is a significant early onset of sensory and motor block in group BB.

**Table 4: Recovery time of sensory and motor among groups.**

| Variables | Lignocaine + buprenorphine, mean (SD) | Lignocaine, mean (SD) | P value |
|---|---|---|---|
| **Sensory (secs)** | 244.3 (14.4) | 184.3 (15.8) | <0.001 |
| **Motor (secs)** | 303.7 (18.8) | 245.6 (18.6) | <0.001 |

There is a significantly prolonged sensory and motor block in group BB.

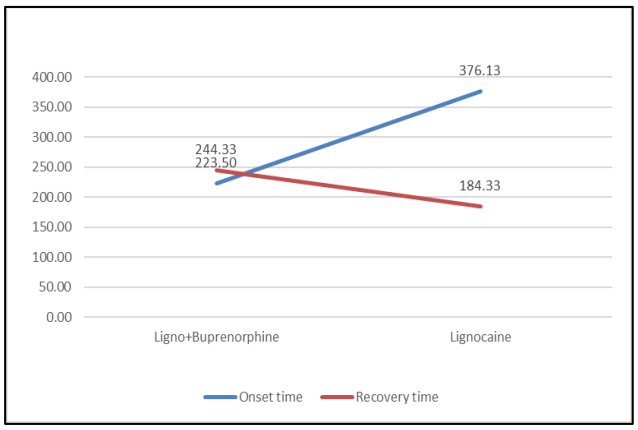


**Figure 3: Onset and recovery time of sensory block.**

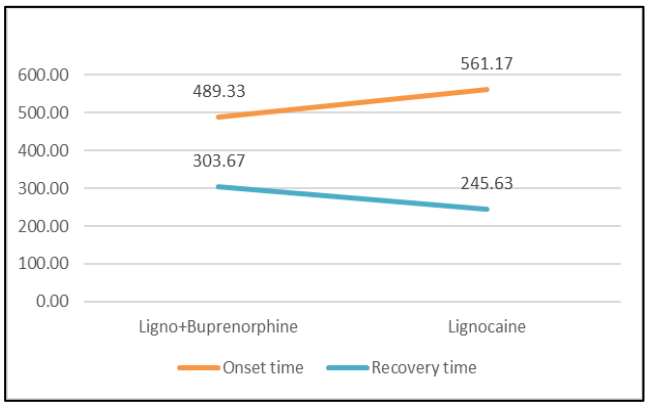


**Figure 4: Onset and recovery time of motor block.**

**Table 5: Time from torniquet release to analgesia among groups.**

| Variables | Lignocaine + buprenorphine, mean (SD) | Lignocaine, mean (SD) | P value |
|---|---|---|---|
| **Torniquet release to analgesia (mins)** | 428.2 (8.2) | 97.5 (26.2) | <0.001 |

There is a significantly prolonged analgesia and delayed requirement of first rescue analgesia in group BB.

## DISCUSSION

In the era of day care surgery, intravenous regional anesthesia the method of anesthesia for upper limb surgeries as it provides adequate relaxation; also cost effective and reliable.[4] it is a popular choice in Trauma and emergency surgeries as patients are ill prepared for general anaesthesia.[4] The major limitation been occurrence of tourniquet pain and no analgesic effect after the tourniquet is released due to rapid perfusion of the limb.[12]IVRA only with lignocaine lead to minimal post-operative analgesia, hence various adjuvants have been tried to overcome the same.[12] Tourniquet pain is a dull and aching sensation at site of tourniquet application, which is directly proportional to the inflation time.[12] Nerve ischaemia and continuous stimulation by skin compression of unmyelinated C fibres have been recognized as the major pathway of pain; these fibres are also more resistant to local anaesthetic conduction block.[12]

Buprenorphine is a synthetic partial μ-receptor agonist which 25-40 times more potent than morphine on parenteral administration. It has a rapid onset and prolonged duration of action; its bell-shaped dose response curve makes it more potential for use and has a low abuse potential.[13]

In our study the, group BB showed early onset of both sensory and motor block compared to Group BL. The shortening effect is attributed to the action of opioids-Buprenorphine, on the peripheral opioid receptors causing the analgesic effect, thereby augmenting the sensory block onset. The recovery from sensory and motor block after tourniquet release was prolonged in group BB compared to group BL. The patients of group BB had prolonged postoperative analgesia, showed better VAS scores and lower requirements of analgesia in postoperative period with no serious side effects.

In a study conducted by Jitendra et al where they added 0.3 mg buprenorphine as an adjuvant to lignocaine in IVRA found earlier onset of sensory block with no effect on motor block compared to lignocaine alone group; they also found better postoperative analgesia in group which

received buprenorphine which is in concurrence with our study.[1]

Bansal et al, conducted a study where group I received 3 mg/kg of lignocaine alone and group II received 1 mg butorphanol in addition to 3 mg/kg lignocaine and concluded addition of butorphanol to lignocaine in IVRA significantly prolongs the duration of postoperative analgesia and lessens 24 hours analgesic consumption.[4] However, there is no effect on sensory block onset time and time to recovery from sensory block.

***Limitations***

Bier's Block can be done for both upper limb and lower limb surgeries. Our study was restricted only to upper limb surgeries. We used standardized doses of lidocaine and buprenorphine instead of weight-based calculations but didn't cross the toxic doses of both, couldn't study effect of different dose of drugs. We used confidence interval of 95%; probably increasing the confidence interval to 98% with a larger number of subjects could have enhanced the sensitivity of our study.

## CONCLUSION

Buprenorphine added as adjuvant to lidocaine in IVRA significantly shortens onset of anaesthesia and also prolongs postoperative analgesia with no serious side effects.

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