

# Comparison of 0.5% Ropivacaine and 0.5% Levobupivacaine for Infraclavicular Brachial Plexus Block

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## SUMMARY

A prospective randomized double-blind study was conducted which involved, 60 ASA 1-2, aged 18-65 years patients, who had elective or emergency orthopaedic surgeries of the upper limbs. They were randomly divided into two groups: Group I received 30 mls of 0.5% ropivacaine; and Group II received 0.5% levobupivacaine for infraclavicular brachial plexus block based on the coracoid approach. The onset time required for sensory block of all required dermatomes (C5-T1) and the onset time of motor block were documented. Based on the Visual Analogue Score, pain scores were recorded every 30 minutes during surgery and at the 6th hour. The mean onset time (SD) for sensory block with ropivacaine was  $13.5 \pm 2.9$  minutes compared to levobupivacaine at  $11.1 \pm 2.6$  minutes ( $p=0.003$ ). The onset time for motor block was  $19.0 \pm 2.7$  minutes in Group I compared to  $17.1 \pm 2.6$  minutes ( $p=0.013$ ) in Group II. Patients in both groups experienced both mild to moderate pain at the 6th hour. In conclusion, there were statistically significant differences in the onset-time for sensory and motor block. However, there was no statistically significant difference in terms of effectiveness of analgesia at the 6th hour. Although the clinical advantage of levobupivacaine is not substantial, its safety profile becomes a major consideration in the choice of local anaesthetic for brachial plexus block where a large volume is required for an effective result.

## KEY WORDS:

brachial plexus block, infraclavicular, levobupivacaine, ropivacaine

## INTRODUCTION

Regional anaesthesia, particularly peripheral nerve blockade is useful for orthopaedic patients. These techniques are often used to provide not only anaesthesia but also post operative analgesia after limb surgery<sup>1</sup>. Brachial plexus block offers many advantages over general anaesthesia for upper limb surgeries such as sympathetic block, better post-operative analgesia and fewer side effects<sup>2</sup>. Since the introduction of long acting local anaesthetics with better safety profiles as well as the availability of better equipment, the usage of peripheral nerve blocks has increased. Supraclavicular block as opposed to infraclavicular brachial plexus block generally offers more dense and complete upper limb anaesthesia but with a higher risk of pneumothorax. However, Arcand *et al* achieved similar surgical anaesthesia using either one of these approaches<sup>3</sup>. The advantages of the infraclavicular approach in brachial plexus block are that it

causes less discomfort to the patient as positioning of the arm is not required and there is a lower incidence of pneumothorax<sup>4</sup>. When compared with the axillary approach, the infraclavicular approach provides better anaesthesia for the arm tourniquet and it has a higher incidence of successful musculocutaneous nerve block<sup>5</sup>.

Levobupivacaine, the S-enantiomer of bupivacaine, is the latest local anaesthetic agent introduced into clinical practice. It is less cardiotoxic compared to racemic bupivacaine<sup>6,7,8,9</sup>. Ropivacaine, the S-enantiomer of S-1-propyl-2, 6-pipecoloxylidide, is an amino-amide local anaesthetic with chemical structure similar to that of bupivacaine. Ropivacaine has been shown to produce less cardiac and central nervous system toxic effects, less motor block and similar duration of sensory analgesia when compared to bupivacaine<sup>6,7,8,9</sup>. The Piangatelli study compared levobupivacaine and ropivacaine in infraclavicular brachial plexus block for upper limb surgery and showed that sensory block duration with levobupivacaine is longer than that of ropivacaine<sup>9</sup>. However, other studies reported conflicting claims. The aim of this study was to compare the effectiveness of 0.5% ropivacaine and 0.5% levobupivacaine given via infraclavicular brachial plexus block in terms of surgical anaesthesia and post operative analgesia for below elbow surgery.

## MATERIALS AND METHODS

This prospective, randomized, double blind study was conducted in the general operation theatre in Universiti Kebangsaan Malaysia Medical Centre after obtaining approval from the Research and Ethics committee, Universiti Kebangsaan Malaysia Medical Centre. Sixty patients, ASA I or II, between the ages of 18 and 65 years, scheduled for below elbow surgery were recruited for this study. Exclusion criteria were patients with known allergy to local anaesthetic, coagulopathy, infection at the site of block, patients with peripheral neuropathy and patients with body mass index  $>35\text{kg/m}^2$ .

After informed consent was obtained, patients were counseled and taught to use the pain score. Patients were randomly divided into two groups: Group I received 30 ml of 0.5% ropivacaine and Group II received 30 ml of 0.5% levobupivacaine for infraclavicular brachial plexus block. Randomization involved the use of sealed envelopes. A sealed envelope was randomly selected and opened by an assistant, with instructions to draw

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up the relevant drug. The syringe was labeled with the patient's name and handed to the investigator who performed the block. An independent observer then observed the onset of sensory and motor blockade and analgesia at 6 hours after blockade.

Patients were not premedicated and received standard anaesthetic monitoring which included an ECG monitor, pulse oximeter and a non invasive blood pressure monitor. An intravenous cannula was inserted into the opposite arm. Baseline haemodynamic data were charted. Preparations were as for general anaesthesia and resuscitation drugs were prepared.

Patient was placed in a supine position with the head facing away from the side of the block. The anatomical landmarks were identified initially. The coracoid process was located and the needle entry point was 2 cm medial and 2 cm caudal to the most prominent part of the coracoid process. After appropriate skin preparation, local anaesthetic was infiltrated at the needle insertion site. A 22 G 100 mm insulated short beveled needle (Stimuplex® HNS11, B.Braun) was used. The needle was introduced vertically at the specific landmark and a nerve stimulator with setting of a current of 2 mA and a frequency of 2 Hz was used. As the nerve was approached, movement of the wrist or fingers elicited was identified and the current was gradually reduced to 0.4 mA. The end point taken was when hand twitches could be elicited at a current of 0.4 mA. Once this was achieved, the local anaesthetic was given in 5 ml increments, aspirating before each bolus to avoid intravascular injection. Patient was monitored closely after completing the local anaesthetic injection. Patient was assessed for loss of sensation to pin prick over the C5-T1 dermatomes using a three-points scale (0= normal sensation, 1= reduced sensation, 2= absent sensation) every 2 minutes for the first 20 minutes and every 5 minutes thereafter till 30 minutes. The onset of motor block was evaluated based on the modified Bromage Scale (0= no paralysis, 1= wrist flexion, 2= elbow flexion, 3= complete block). Block was considered to have failed when sensory anaesthesia was not achieved within 30 minutes. General anaesthesia was given subsequently to these patients who were then excluded from analysis. Any complication such as pneumothorax, haematoma, tinnitus, circumoral numbness, dizziness and seizures was noted and documented. Surgical incision was allowed to begin 30 minutes after analgesia had been established.

Pain score was assessed every 30 minutes during surgery. If the pain score exceeded 2 cm, rescue analgesia in the form of 0.5 µg/kg fentanyl would be given. This would be repeated within 10 minutes interval to a maximum of two times, after which the patient was given general anaesthesia. Instructions were given to the ward nurses to document the pain score using (10 cm) Visual Analogue Score and charted at the 6th hour post block. The first dose of rescue analgesia if needed would be given after the 6th hour.

A sample of sixty patients was taken as this gave sufficient power to show a significant difference of 2 minutes in the onset time between the two groups using data taken from a previous study. Student t-test was used to compare the mean onset of sensory and motor block between Group I and Group II. Chi-square test was used for categorical data in the analysis of the effectiveness of analgesia between the two groups. A p value of <0.05 was considered significant.

## RESULTS

Sixty patients were recruited but only fifty two patients were analyzed for this study. Patients' demographic characteristics, site and duration of surgery are detailed in Table I. There were no significant differences between both groups with respect to the above parameters.

## DISCUSSION

Regional anaesthesia is useful in surgeries involving the limbs. The advantages of regional anaesthesia over general anaesthesia are numerous and have been clearly established. These include excellent perioperative (pre-, intra and post-operative) analgesia that can be extended into the post operative period by utilizing a continuous regional technique, avoidance of opioid-related side-effects (particularly nausea, vomiting and sedation), avoidance of airway instrumentation, decrease in post-operative intensity of care, decrease recovery time and improved patient satisfaction<sup>1,2</sup>.

Several approaches to the brachial plexus have been described. Labat in 1922, first described the infraclavicular approach to the brachial plexus sheath, in order to accomplish regional anaesthesia in forearm and hand surgery<sup>7</sup>. Numerous modifications to this technique have been made by Raj, Kilka, Borgeat, Jandard, Salazar, Sims, Whiffler, Wilson, Kapral,<sup>10,11,12,13,14,15,16,17,18,19</sup> and several recent investigators. It is safe and easy to perform with a high success rate for forearm and hand surgery. Other advantages include: better anaesthesia for arm tournique, no need for arm abduction when performing the block and less frequency of failure to block the musculocutaneous nerve. However, it is associated with a higher frequency of incomplete blockade, essentially for the ulnar nerve<sup>20</sup>. Randomised clinical trials comparing efficacy for brachial plexus approaches for forearm and hand surgery are few in number. Two promising prospective studies which compared coracoid infraclavicular and axillary brachial plexus block revealed conflicting results.<sup>10,20</sup>

Local anaesthetic agent selection, dose, concentration, volume and physical modifications can affect onset, spread, quality and duration of anaesthesia. An important clinical consideration is the ability of local anaesthetics to cause a differential sensory and motor block. Ropivacaine, a long acting local anaesthetic, has been reported to be less toxic than bupivacaine. In vitro studies have demonstrated that ropivacaine is a potent blocker of A $\delta$  and C fibres (pain fibres)<sup>11</sup>. Levobupivacaine, the S-enantiomer of bupivacaine, which has less cardiac and neural toxicity than bupivacaine, is currently the closest to the ideal agent for neural blockade.

The onset of sensory and motor block is related to the physicochemical properties of the individual drugs, namely the mass of the injected local anaesthetic (mass = concentration X volume), the pKa of the drug, pH of the tissues, presence of frequency dependent blockade. Theoretically, ropivacaine may cause a higher degree of sensory block, or at least faster than that of motor nerve fibres compared with bupivacaine<sup>9</sup>. However, Casati et al, demonstrated that 30 ml of 0.5% levobupivacaine produced an interscalene brachial plexus block of similar onset and quality as one produced by the same volume of 0.5% ropivacaine<sup>21</sup>. Similar findings were also reported by Liisanantti et al, who compared the use of high dose bupivacaine, levobupivacaine or ropivacaine for axillary brachial plexus block which showed no statistical difference in

**TABLE I : Demographic characteristics, site and duration of surgery. Values expressed in mean  $\pm$  standard deviation (SD) and number.**

|  | Group I<br>(n=28) | Group II<br>(n=24) |
|--|-------------------|--------------------|
| Age (years)                            | 33.9 $\pm$ 12.4   | 32.9 $\pm$ 13.3    |
| Gender (male:female)                   | 23 : 5            | 19 : 5             |
| Race (Malay:Chinese:Indian:Others)     | 10 : 9 : 3 : 6    | 11 : 5 : 5 : 3     |
| Weight (kg)                            | 65.7 $\pm$ 11.3   | 65.3 $\pm$ 11.0    |
| Site of surgery (below wrist :forearm) | 7 : 21            | 9 : 15             |
| Duration of surgery (minute)           | 107.6 $\pm$ 31.8  | 109.1 $\pm$ 38.2   |

There were significant differences in the onset of sensory and motor block as shown in Table II. Levobupivacaine 0.5% (11.1  $\pm$  2.6) had a faster onset of sensory and motor block compared to ropivacaine 0.5% (13.5  $\pm$  2.9).

**TABLE II : Duration required for the onset of sensory block. Values expressed as mean  $\pm$  standard deviation (SD).**

|                                 | Group I<br>(n=28) | Group II<br>(n=24) | P value |
|---------------------------------|-------------------|--------------------|---------|
| Onset of sensory block (minute) | 13.5 $\pm$ 2.9    | 11.1 $\pm$ 2.6     | 0.003   |
| Onset of motor block (minute)   | 19.0 $\pm$ 2.7    | 17.1 $\pm$ 2.6     | 0.013   |

There was no significant difference in the severity of pain at 6th hour of surgery between both the groups, as all study patients gave pain score of zero. The block failure rate was relatively higher in the levobupivacaine group (20%) as compared to the ropivacaine group (6.7%). However the difference was not statistically significant. There was only one notable complication, which was a haematoma at the site of the insertion, in the ropivacaine group.

the quality of sensory block between the drugs at 5 minutes, 15 minutes and 30 minutes after injection<sup>22</sup>. However, other investigations have observed that ropivacaine produced a slightly better intensity of sensory and motor block than that of the same dose of levobupivacaine<sup>9</sup>.

C. Piangatelli et al compared 0.5% levobupivacaine with 0.75% ropivacaine in the infraclavicular brachial plexuses block, showed that the onset time for motor block was greater in the ropivacaine group. The sensory block also was longer in the levobupivacaine group<sup>9</sup>. When comparing 0.5% ropivacaine with 0.5% levobupivacaine for brachial plexus block injected through an interscalene catheter, followed by a patient controlled interscalene analgesia with 0.2% ropivacaine and 0.125% levobupivacaine, Casati et al reported no difference in onset time, quality of intraoperative anaesthesia, efficacy of postoperative analgesia and recovery of motor function.<sup>20</sup> Hickey et al compared 0.25% ropivacaine with 0.25% bupivacaine for brachial plexus block for upper limb surgery, and showed that although motor onset was quicker in the bupivacaine group, there was no significant differences in terms of onset of sensory block<sup>22</sup>. However, due to the low concentration of local anaesthetic used, frequent supplementation was required.

In a study done by Cline E et al comparing 0.5% levobupivacaine with 0.5% ropivacaine in patients undergoing axillary brachial

plexus block, the ropivacaine group had slightly higher verbal numerical rating scale (VNRS) scores at 8th and 10th hours post operative<sup>8</sup>. However, in this study patients in both groups experienced no pain 6 hours after the block was given. In another study, Liisanantti et al concluded that axillary brachial plexus block with 45 ml of 0.5% racemic bupivacaine, levobupivacaine and ropivacaine produced adequate anaesthesia without any clinically significant differences between the drugs<sup>22</sup>.

There are not many controlled studies comparing different local anaesthetic agents for brachial plexus block. Concrete conclusions are difficult to make due to variable factors in particular block techniques used and how success and duration were defined<sup>23,24</sup>. A limitation of this study was that the complete duration of the block was not assessed. However, previous studies showed that levobupivacaine had a longer duration of sensory block compared to ropivacaine for infraclavicular brachial plexus block. There is still controversy over the clinical potency of levobupivacaine, ropivacaine and racemic bupivacaine relating to sensory and motor blockade<sup>26</sup>.

In conclusion, the onset of sensory and motor block was faster with 0.5% levobupivacaine compared to 0.5% ropivacaine in infraclavicular brachial plexus block for below elbow surgery. However, there was no difference in effectiveness of analgesia 6 hours post operatively between the two drugs.

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