A Comparative Study on Efficacy Between Levobupivacaine and Ropivacaine for Upper Limb Surgeries Under Supraclavicular Brachial Plexus Block

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ABSTRACT

BACKGROUND

Regional anaesthesia technique has increased in modern anaesthesia practice. It is safer, with less haemodynamic changes, intact consciousness, avoiding airway instrumentation, providing rapid recovery and longer postoperative analgesia. However, the toxicity of bupivacaine is a concerning issue. Hence the present study aimed to compare the effectiveness of the newer drugs levobupivacaine and ropivacaine in supraclavicular brachial plexus block.

METHODS

In this prospective and double blinded study, 60 patients of either sex, aged 18 to 60 years, ASA I and II undergoing upper limb surgeries were randomized into two groups of 30 patients each either to receive supraclavicular brachial plexus block of 0.5% levobupivacaine (Group L) and 0.5% ropivacaine (Group R) respectively to study its efficacy and block characteristics.

RESULTS

The onset time was faster for sensory (9.40 ± 1.58 mins versus 12.46 ± 1.79 mins; $p<0.001$) as well as motor (11.26 ± 1.61 mins versus 14.26 ± 1.72 mins; $p<0.001$) in Group L compared to Group R. The duration of sensory block was also significantly longer in group L compared to group R (742.83 ± 55.62 minutes versus 618.33 ± 64.27 minutes) and the duration of motor block was significantly longer in group L compared to group R (689.50 ± 45.85 minutes versus 548.16 ± 57.48 minutes; $p<0.01$). The time to first rescue analgesia was longer in group L compared to group R (792.66 ± 62.6 minutes versus 661.50 ± 62.87 minutes; $p<0.01$).

CONCLUSIONS

Levobupivacaine provided faster onset of sensory and motor block, longer duration of sensory and motor block with better postoperative analgesia than ropivacaine in supraclavicular brachial plexus block.

KEYWORDS

Levobupivacaine, Ropivacaine, Supraclavicular Brachial Plexus

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BACKGROUND

There is increased popularity in brachial plexus blocks for upper limb surgeries as it provides good surgical anaesthesia and post-operative analgesia. This technique has been replacing general anaesthesia and has added advantages as they are simple, safe, preserves consciousness, avoids airway instrumentation and also provides rapid recovery with early ambulation with significant postoperative analgesia.[1] The supraclavicular block is often called "the spinal anaesthesia of the upper extremity" as it has high success rate because of the anatomic characteristics and also it provides complete anaesthesia below midarm.[2,3] Use of peripheral nerve stimulator allows better localization of the nerves/plexus and minimizes the complications of blind techniques.[4,5] Previously, the commonly local anaesthetic drug used for brachial plexus block is bupivacaine as it has longer duration of action and a favourable ratio of sensory to motor neural block but its toxicity is a concerning issue. So, there is need to search for new drugs with wider safety margin, and also possessing the desirable pharmacokinetic properties of bupivacaine. Other local anaesthetic drug like levobupivacaine,[6] the S-enantiomer of bupivacaine is a latest anaesthetic agent introduced into clinical practice and is currently close to the ideal agent for neural blockade due to its less cardiac and neural toxicity properties. Another local anaesthetic ropivacaine[7] is also a long acting pure S enantiomer and is considered to be less cardiotoxic than bupivacaine with similar pharmacodynamics properties. It is less likely to penetrate large myelinated motor nerve fibers, resulting in a relatively reduced motor blockade. Hence, the present study is aimed to compare the effectiveness of 0.5% levobupivacaine and 0.5% ropivacaine in supraclavicular brachial plexus block in terms of onset and duration of sensory and motor blockade, duration of analgesia, requirement of postoperative analgesia and complications, if any.

METHODS

The study was a randomized, prospective, double blinded study conducted in the Department of Anaesthesiology, in a tertiary care centre, Imphal, Manipur, India, over a period of two years from October 2016 to September 2018 following approval from the Institutional Ethics Committee. Sixty (60) patients with American Society of Anesthesiologist (ASA)[8] grade I or II status, between 18-60 years of either sex, scheduled for elective orthopaedics upper limb surgery were recruited for the study. They were randomly allocated to one of the two groups using a web based randomization chart, with 30 patients in each group as -group L (levobupivacaine group): received inj. levobupivacaine 0.5%, 30ml and group R (ropivacaine group): received inj. ropivacaine 0.5%, 30ml. Patients who were hypertensive, diabetic, neuropathic, history of peripheral nerve injury, geriatric, paediatric, pregnancy and lactation, patient on anticoagulants or bleeding disorder, patients with history of hypersensitivity to amide group of local anaesthetic agents were excluded from the study.

A uniform anaesthetic protocol was maintained for all the enrolled patients. Pre-anaesthetic check-up for patients were done a day prior to surgery and they were explained about the procedures and valid written informed consent were taken. On the day of surgery when patient reached the operation theatre, intravenous cannulation was done with 18/20 G cannula in non-operating hand. Standard monitoring of heart rate (HR), electrocardiography (ECG), oxygen saturation (SpO2), non-invasive blood pressure (NiBP), etc, were done continuously. All patients were preloaded with 15 mL/Kg of ringer lactate solution over 15 minutes before administration of brachial plexus block, and also pre-medicated with inj. ranitidine 150 mg and inj. ondansetron 4 mg intravenously. Brachial plexus block was then performed by supraclavicular approach using Peripheral Nerve Stimulator- (Plexygon, Vygon Company, United Kingdom).

The study drugs were prepared by a different investigator unknown to the one who conducted the block. The surgery was allowed after 25-30 minutes of injection. Failure of loss of arm abduction or pain at surgical site after 30 min was considered to be block failure. Grading of sensory block was done by Hollmen scale [9] for sensory block as: Scale 1: normal sensation of pinprick, Scale 2: weaker sensation of pin prick felt as compared with other upper limb, Scale 3: pin prick recognized as touch with blunt object, Scale 4: no perception of pin prick. And also Hollmen scale[10] for motor block (Scale 1: normal muscle function, Scale 2: slight weakness in function, Scale 3: very weak muscular action, Scale 4: complete loss of muscle action) were again used for motor weakness. Sensory block findings were recorded at an interval of 2 minutes till a complete sensory block was achieved.

The onset time of the sensory block (OTSB) was taken as a minimum of scale 3 and complete block as scale 4. Duration of sensory block was the time from Hollmen scale 3 to recovery to Hollmen scale 1. For motor blockade of the upper extremity, the finding were recorded every 2 minutes from time of start of injection till the complete loss of the motor power was achieved i.e. Hollmen scale 4. The time of onset of motor block was considered as grade 3 and complete motor block as grade 4 for motor block of Hollmen scale. The duration of motor block was considered from Hollmen scale 3 to recovery of muscle power. i.e. Hollmen scale 1. Post-operative analgesia was taken as time elapsed between injection of the local anaesthetic solution and the complete resolution of anaesthesia in post-operative period when the patient start complaining of pain with VAS(visual analogue scale) score ≥4.[11] Rescue analgesia were provided by inj. tramadol hydrochloride 100 mg intravenous when VAS was more than 4. The haemodynamic parameter and side effects involved with the study were also recorded at different time points in the study We recruited 30 patients for each group based on earlier study by Ilham C et al[12] with α value of 5% and power of 80%.

The data recorded was analysed using the Statistical Package for Social Sciences (SPSS), 21 version. Numerical/continuous variables were reported as Mean ± SD (standard deviation) and compared by student 't' test while χ^2 test were applied for categorical variables. P-values of <0.05 and <0.01 were treated as the cut off values for significance and highly significance respectively.

RESULTS

The demographic parameters such as age, sex, weight, ASA between the two groups were comparable and did not affect the study outcome, as shown in table 1. The sensory onset time, as shown in table 2 was faster in group L (9.40 ± 1.58 mins) as compared to group R (12.46 ± 1.79 mins), p<0.001 (highly significant) and motor onset time was also faster in group L (11.26 ± 1.61 mins) as compared to group R (14.26 ± 1.72 mins), p<0.001 (highly significant). The duration of sensory block was longer in group L (742.83 ± 55.62 minutes) compared to group R (618.33 ± 64.27 minutes), p<0.001 and the duration of motor block was also significantly longer in group L (689.50 ± 45.85 minutes) compared to group R (548.16 ± 57.48 minutes) (p<0.001). The time to first rescue analgesia was higher in group L (792.66 ± 62.6 minutes) as compared to group R (661.50 ± 62.87 minutes) and highly significant (p<0.01).

There was no case of failed block or patchy block in both the groups. None of the patients in either groups required supplemental analgesia or general anaesthesia and qualities of the operative conditions were also excellent. Intra- and post-operative haemodynamic parameters did not deviate from the baseline value and were comparable in both the groups. There were no side effects during the study period.

Parameters	Group L	Group R	p
Age in years (Mean ± SD)	36.17 ± 11.90	35.43 ± 12.66	0.818
Sex(M/F)	20/22	10/8	0.573
Weight in Kgs (Mean ± SD)	66.26 ± 6.83	67.23 ± 5.21	0.541
ASI (I/II)	27/3	28/2	0.640

Table 1. Comparison and Distribution of Demographic Parameters in the Two Groups

Block Parameters	Group L (Mean ± SD)	Group R (Mean ± SD)	p
Sensory block onset (mins)	9.40 ± 1.58	12.46 ± 1.79	<0.001*
Motor block onset (minutes)	11.26 ± 1.61	14.26 ± 1.72	<0.001*
Sensory block duration (mins)	742.83 ± 55.62	618.33 ± 64.27	<0.001*
Motor block duration (mins)	689.50 ± 45.85	548.16 ± 57.48	<0.001*
Time to request for first rescue analgesia (mins)	792.66 ± 62.6	661.50 ± 62.87	<0.001*

Table 2. Comparison of Block Characteristics in the Two Groups

*= Significant

DISCUSSION

Generally surgeries on the upper limb are performed under general anaesthesia but now a days there is increasing popularity in regional anaesthesia for upper limb surgeries due to escalating cost and side effects involved with general anaesthetic agents. Moreover there is avoidance of airway instrumentation in regional anaesthesia. The haemodynamic changes of general anaesthesia and associated sequelae (nausea, vomiting, dry mouth, sore throat, hoarseness, shivering, dizziness, post-operative cognitive dysfunction) can also be avoided and postoperative pain relief is also an added advantage of regional techniques. Regional anaesthesia may also be safer in general anaesthesia contraindicated patients.[13]

Among various types of brachial plexus block the supraclavicular approach has been considered the most efficacious. It is often described as "spinal anaesthesia for upper extremity" because of its ubiquitous application for upper extremity surgeries and characteristically associated with a rapid onset of anaesthesia with high success rate, and complete and predictable anaesthesia for upper extremity.[14] Bupivacaine is the commonly used local anaesthetic drug for brachial plexus block because of its longer duration of action and a favourable ratio of sensory to motor neural block.[15] However, its toxicity is a concerning issue especially when larger doses are used in peripheral nerve blocks or prolonged infusions for postoperative analgesia.[16,17] Hence, the need of a new drug with wider safety margin, and desirable pharmacokinetic properties of bupivacaine was felt.

Newer local anaesthetic drug Levobupivacaine,[18] the S-enantiomer of bupivacaine is currently closest to the ideal agent for neural blockade as it has less cardiac and neural toxicity than bupivacaine. Another local anaesthetic ropivacaine[19] is also a long acting pure S enantiomer and considered to be less cardiotoxic than bupivacaine with similar pharmacodynamics properties. It is less likely to penetrate large myelinated motor nerve fibers, resulting in a relatively reduced motor blockade. In our study, the mean onset time of sensory block in group L (levobupivacaine group) 9.40 ± 1.58 minutes was faster significantly (p<0.001) when compared with group R (ropivacaine group) 12.46 ± 1.79 minutes. This result is consistent with the study of Mageswaran R and Choy YC[20] where the mean onset time for ropivacaine was 13.5 ± 2.9 minutes as compared to levobupivacaine which was 11.1 ± 2.6 minutes (P=0.003). Our result was also supported by the study of Kulkarni SB et al[14] where the onset of sensory block with levobupivacaine was faster than that with ropivacaine (8.60 ± 1.522 min Vs 9.533 ± 1.655 min).

However, in the study conducted by Mankand P et al[21] both 0.5% levobupivacaine and 0.5% ropivacaine showed no statistically significant difference in the onset of sensory block as they explained that the blockade of C fibres by most of the local anaesthetic agents is approximately at the same rate. The duration of sensory block in our study was significantly prolonged in group L (742.83 ± 55.62 minutes) as compared to group R (618.33 ± 64.27 minutes) and similar findings were reported by Kulkarni SB et al[14] where significant longer duration of sensory block with 0.5% levobupivacaine (12.116 ± 0.715 hrs) was observed when compared with 0.5% ropivacaine (11.316 ± 2.012 hrs). Comparable results were also obtained with the study by Cline E et al[22] where the duration of sensory analgesia was

significantly longer in levobupivacaine group (831 minutes) than in ropivacaine group (778 minutes). In the study of Gonzalez-Suarez S, et al[23] with axillary brachial plexus block, the sensory block was 9.2 ± 3.1 hours for ropivacaine and 11.3 ± 4.1 hours for levobupivacaine which is in concordance with our result. In our study, the mean onset time of motor block was faster in group L (11.26 ± 1.61 minutes) when compared to group R (14.26 ± 1.72 minutes) which is in agreement to the findings of Mageswaran R and Choy YC[20] done in upper limb orthopaedic surgeries by infraclavicular brachial plexus block. They found that the onset of motor block was 17.1 ± 2.6 minutes in levobupivacaine group and 19.0 ± 2.7 minutes in ropivacaine group.

Similarly, comparable result was observed by the study of Kulkarni SB et al[14] and they found that onset of motor block in levobupivacaine group was 13.133 ± 2.012 minutes when compared to 14.60 ± 2.252 minutes in ropivacaine group. This slower onset of motor block with ropivacaine may be attributed to the 10 times less lipophilicity of ropivacaine than levobupivacaine, resulting in resistance to rapidly penetrating the myelinated nerve fibers and easily induction of local vasoconstriction in tissue surrounding the injection site.[24] The total duration of motor block in our study was significantly prolonged in group L (689.50 ± 45.85 minutes) as compared to group R (548.16 ± 57.48 minutes).

Our result was comparable with the finding of Cline E et al[22] which were 1047 minutes in levobupivacaine group and 778 minutes in ropivacaine group. Kulkarni SB et al[14] also observed a longer duration of motor block in group L (11.316 ± 1.021 hours) as compared to group R (8.50 ± 0.415 hours) which was highly significant and comparable with our finding. In our study, the time to first rescue analgesia was significantly greater in group L (792.66 ± 62.6 minutes) when compared with group R (661.50 ± 62.83 minutes), P <0.001 which is comparable with the study of Kulkarni SB et al.[14] Also, in the study by Casati A et al,[25] the mean first request for pain medication occurred after 13 hr (11-14 hr) with 0.75% ropivacaine, 18 hrs (15-19 hrs) with 0.75% levobupivacaine and 16 hrs (13-20 hrs) with 0.5% levobupivacaine in sciatic nerve block which was supportive of our study. All the patients in our study were monitored postoperatively for any complications like hypotension, bradycardia, postoperative pain, paraesthesia, myonecrosis, headache and allergic reactions if any and no complications were recorded in any of the patients. Thus, in general, levobupivacaine showed a better quality of analgesia with a shorter onset and prolong recovery time for both sensory and motor blockade in comparison to ropivacaine.

Limitations

The actual duration of sensory and motor blocks was not evaluated by electromyography or nerve conduction velocity. The need for studies with other ASA physical status needs to be evaluated. Adjuvants and ultrasound guidance for better block characteristics is the need of the hour.

CONCLUSIONS

Levobupivacaine provides faster onset of sensory and motor block, longer duration of sensory and motor block and better post-operative analgesia than ropivacaine in supraclavicular brachial plexus block using peripheral nerve stimulator without significant side effects. The longer duration of sensory block associated with good analgesia and lesser toxicity makes levobupivacaine a better choice for upper extremity blocks.

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