A Prospective Observational Study to Compare the Effectiveness of Bupivacaine Versus Levobupivacaine in Supraclavicular Brachial Plexus Block

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ABSTRACT

Introduction: Increasing knowledge in regional anaesthesia coupled with newer technologies to locate peripheral nerves has led to a surge in the usage of regional anaesthesia for upper limb surgeries. Newer drugs like levobupivacaine have lesser side effects compared to racemic bupivacaine. The aim was to compare the efficacy of bupivacaine and levobupivacaine for supraclavicular brachial plexus block.

Material and methods: 60 patients of ASA I-II status in the age group of 18-60years given supraclavicular brachial plexus block for upper limb surgery were included. We used the classical approach to supraclavicular block using a single-injection, nerve-stimulator technique. Patients in group B received bupivacaine while those in group L received levobupivacaine. Onset and duration of sensory and motor block was recorded. Duration of analgesia was considered as the time taken to reach an NRS score of 3. After data collection, data analysis was done with the help of SPSS software Ver 15 and Sigma Plot Ver 12.Quantitative data is presented with the help of Mean & Standard Deviation, comparison between the study groups is done with the help of Unpaired T test. Qualitative data is presented with the help of percentage table, association among study group is assessed with Chi-Square test. P Value<0.05 is considered significant.

Result: Levobupivacaine had a faster onset & longer duration of both sensory and motor blockade as compared to racemic bupivacaine. The hemodynamic profile of both drugs was similar and no adverse effect was found with either drug.

Conclusion: We conclude that in peripheral nerve blocks where large volumes of local anaesthetic is required, levobupivacaine could be a suitable choice as it is known to have less toxic potential.

Keywords: Supraclavicular Brachial Plexus Block, Levobupivacaine, Bupivacaine, Upper Limb, Analgesia

INTRODUCTION

Peripheral nerve blocks are widely used for surgical anesthesia as well as for both postoperative and nonsurgical analgesia. The aim is to have a technique which is feasible, minimally invasive, less time consuming, provides prolonged analgesia and has least number of complications.

Brachial plexus block is a regional technique commonly employed for upper limb surgeries. The advantages offered by regional blocks for upper limb surgeries over general anesthesia include pre-emptive analgesia, stable intra-operative hemodynamics, lesser incidence of postoperative nausea and vomiting[1], superiorpost-operative analgesia[2], less time in post anesthesia care unit (PACU)[1]and shorter hospital stay[3]. The associated sympathetic blockade decreases vasospasm and edema[4].

Upper limb surgeries can be performed under various regional blocks such as supraclavicular, infraclavicular, interscalene, axillary etc. The various techniques for nerve location include ultrasound, peripheral nerve stimulator and elicitation of paresthesia. We chose the supraclavicular approach using peripheral nerve stimulator for our study.

The local anesthetics traditionally used have been lignocaine and bupivacaine with or without adjuvants. The adjuvants used to enhance the onset time, prolong blockade[5] and reduce the dosage of local anesthetic include adrenaline, sodium bicarbonate, opioids, alpha 2 adrenergic agonists etc. Racemic bupivacaine provides a long duration of action and has a favorable ratio of sensory to motor neural block. However, the dextro-enantiomer in the racemic mixture of bupivacaine results in cardiac and central nervous system toxicity[6]. Hence, levobupivacaine which is the levo-enantiomer of bupivacaine, is gaining popularity since it is known to cause lesser cardiac toxicity than racemic bupivacaine[7,8].

We decided to compare the effectiveness of bupivacaine and levobupivacaine for supraclavicular brachial plexus block in upper limb surgeries. The onset and duration of sensory and motor blockade, duration of analgesia and the hemodynamic profile of the groups receiving the drugs were compared.

MATERIAL AND METHODS

Our study was conducted in 60 patients of ASA I & II status in the age group of 18-60 years given brachial plexus block

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by supraclavicular approach for various upper limb surgeries, after receiving institutional ethics committee approval. Patients allergic to any of the study drugs; on anticoagulants or with altered coagulation profiles; local infection at the site of injection; history of psychiatric, neuromuscular, cardiovascular, pulmonary, renal, hepatic disease; drug abuse; patients requiring bone graft; on chronic analgesic therapy, difficult anatomical landmarks, diaphragmatic paralysis &/or pneumothorax on the contralateral sideand patients who did not give consent for the procedure were excluded from the study.Detailed pre anesthetic checkup was done. Patients were explained about the procedure & numerical rating scale (NRS) in detail and written informed consent was obtained. Patients did not receive any sedative premedication before arrival in the operation theatre. In the operation theatre, baseline pulse, blood pressure, oxygen saturation and respiratory rate were noted.The patient was positioned and need for cooperation was emphasized.

We used the classical approach to supraclavicular block using a single-injection, nerve-stimulator technique. An experienced anesthesiologist performed the block using a nerve locator (B Braun Germany) with all aseptic precautions. Local infiltration of 1ml of 2% lignocaine was given at the puncture site by raising a skin wheal using a 24G 1.5-inch needle. Stimuplex HNS 12® (B. Braun, Melsungen, Germany) was used as a nerve stimulator and Stimuplex A (B. Braun, Mensulgen, Germany; 22G, 50mm) was used as a block needle. We aimed to elicit an isolated muscle twitch in all fingers either in flexion or extension. Once the elicited motor response of the fingers was obtained at 1mA, the current was gradually decreased up to 0.5mA while advancing the needle until maximum contraction was elicited; the study drug was injected after gentle aspiration with repeated aspiration every 5ml. During the conduct of block and thereafter, the patient was observed vigilantly for any toxicity to the drugs injected or complications of the block.

This was an observational study where patients who received bupivacaine were included in group B and those who received levobupivacaine were included in group L. As per the operation theatre's routine protocol, patients in group B received 20ml bupivacaine (0.5%), 10ml lignocaine (2%) with adrenaline (1:200,000) while those in group L received 20ml levobupivacaine (0.5%), 10ml lignocaine (2%) with adrenaline (1:200,000).

Heart rate and blood pressure were documented every 5 minutes up to half an hour and then every 15 minutes up to 2 hours & then half hourly up to 6 hours. Variation in hemodynamics >20% from baseline was considered significant.Patients were observed for any side effects and complications like CNS toxicity, cardiac arrhythmias, pneumothorax, hematoma and post block neuropathy etc. Patients with complete failure of the block or unsatisfactory block (inadequate analgesia), inadequate relaxation and patients requiring either intravenous sedation or general anesthesia were excluded from the study.

The assessment for onset of sensory and motor block was done every minute from the time of injection of drug until the block was completely established. Time "0 minute" was taken as the time of completion of injection. Dermatomes C5 to T1 were assessed using cotton soaked in spirit.

Onset time of sensory block was the time to diminished response to cold in any dermatome while onset time of motor block was the time elapsed from injection of drug to inability to flex the forearm or wrist. Surgery was commenced after complete motor block when the patient was unable to move the upper limb.

Duration of sensory block (time elapsed between injection of the drug and return of cold sensation in any dermatome) and duration of motor block (time elapsed between injection of drug to ability to flex the forearm or wrist) was recorded.

Intensity of postoperative pain was assessed using the NRS explained to the patient preoperatively. NRS was assessed postoperatively every half hourly until a score of 3 was attained. Rescue analgesia was given in the form of diclofenac sodium (1.5 mg/kg) intravenously at NRS of 3 and the time of administration was noted. Duration of analgesia was considered as the time from onset of sensory block till NRS score of 3 was achieved.

Patients were observed postoperatively for any complications of the block. In case of suspected pneumothorax, a chest X-ray was done.

STATISTICAL ANALYSIS

After data collection, data entry was done in Excel. Data analysis was done with the help of SPSS software Ver 15 and Sigma Plot Ver 12. Quantitative data is presented with the help of Mean & Standard Deviation, comparison between the study groups is done with the help of Unpaired T test. Qualitative data is presented with the help of Frequency and Percentage table, association among study group is assessed with Chi-Square test. P Value <0.05 is considered statistically significant.

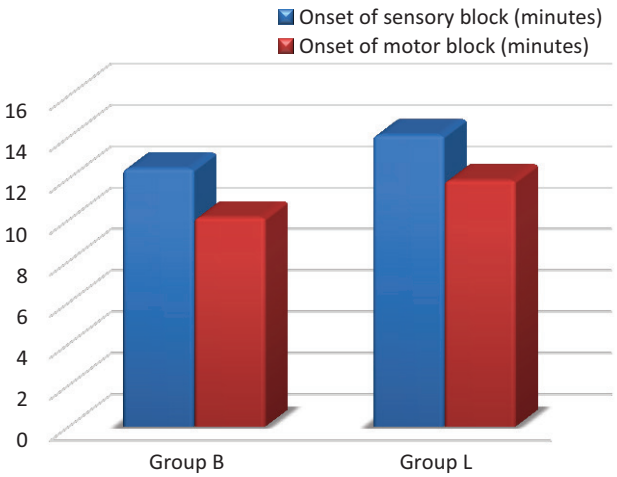
RESULT

There was no statistically significant difference between two groups in demographic data i.e. age, gender, weight, ASA status (Table 1).

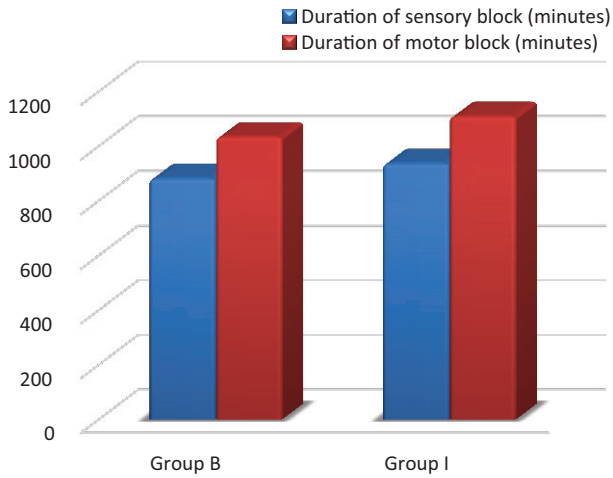
The mean onset time of sensory block was 12.48 minutes in group B & 10.13 minutes in group L while the mean onset time of motor block was 14.1 minutes in group B & 11.92 in group L. Mean onset time of sensory and motor block were significantly shorter in group L than in group B (Table 2 and Graph 1).

The mean duration of sensory block was 881.4±124.45minutes in group B & 1034.5±146.65 minutes in group L while the mean duration of motor block was 936.83±116.45 minutes in group B & 1109.17±146.33 minutes in group L (Graph 1) Mean duration of sensory and motor block are significantly longer in group L that in group B (Table 2).

The mean duration of analgesia was 909±122.24 minutes in group B and 1073.8±147.44 minutes in group L (Graph 3). The mean duration of analgesia was significantly prolonged in group L compared to group B (Table 4).



Graph-1: Mean onset time of sensory and motor block



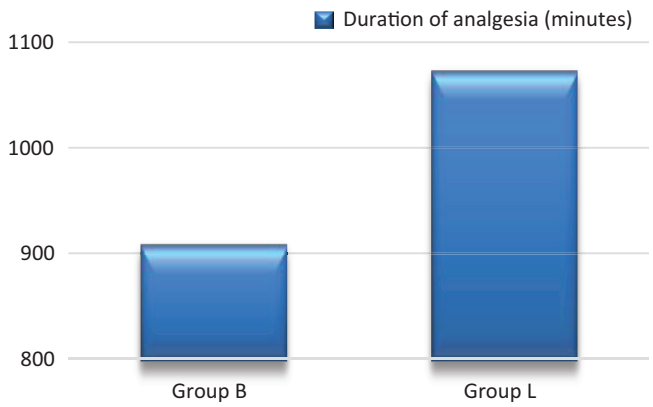
Graph-2: Mean duration of sensory & motor block

Study parameter	Group B (n=30)	Group L (n=30)	P value
Age (years)	36.67±8.59	35.86±8.63	>0.72
Weight (kg)	61.7±6.3	62.43±6.74	>0.67
ASA I:II	21:9	17:13	>0.05

Table-1: Comparison of demographic data of the two groups.

Study Parameter	Group B (mean ± SD)	Group L (mean ± SD)	P value
Onset of sensory block	12.48±3.83	10.13±2.34	0.006
Onset of motor block	14.1±3.85	11.92±2.29	0.01

Table-2: Mean onset time of sensory and motor block in Group B and L.



Graph-3: Mean duration of analgesia.

Study Parameter	Group B (mean±SD)	Group L (mean±SD)	P value
Duration of sensory block (minutes)	881.4 ± 124.45	1034.5 ± 146.65	<0.001
Duration of motor block (minutes)	936.83 ± 116.45	1109.17 ± 146.33	<0.001

Table-3: Mean duration of sensory and motor block

Study Parameter	Group B (mean±SD)	Group L (mean±SD)	P value
Duration of analgesia (minutes)	909 ± 122.24	1073.8 ± 147.44	<0.001

Table-4: Mean duration of analgesia.

Time (minutes)	Pulse Rate (beats per minute)			
	Group B	Group L	P value	Inference
0 (baseline)	79.5±8.9	76.83±9.66	0.27	Not significant
30	76.6±6.02	79.86±9.39	0.11	Not significant
60	80.9±5.82	81.83±9.42	0.65	Not significant
90	79.6±4.69	81.8±9.24	0.24	Not significant
120	80.37±4.9	79.5±9.33	0.65	Not significant

Table-5: Comparison of pulse rate at different time intervals in the two groups.

Time (minutes)	Mean arterial pressure (mm Hg)			
	Group B	Group L	P value	Inference
0 (baseline)	85.6±4.63	86.2±7.81	0.718	Not significant
30	87.4±5.75	85.5±6.93	0.252	Not significant
60	87.7±5.43	85.2±7.01	0.127	Not significant
90	86.93±6.05	84.87±7.21	0.30	Not significant
120	86.93±5.13	84.6±6.87	0.142	Not significant

Table-6: Comparison of mean arterial pressure at different time intervals.

The pulse rate was slightly lower while the mean arterial pressure was slightly higher in group B compared to group L (Graph 4 and graph 5). However, this difference was not statistically significant (Table 5 and table 6).

DISCUSSION

Brachial plexus block is close to the ideal anaesthetic technique for upper limb surgeries as it provides good intraoperative anaesthesia & postoperative analgesia. Racemic bupivacaine is the most commonly used local anaesthetic agent for brachial plexus block. However, reports of fatalities through cardiovascular (CVS) & central nervous system (CNS)[9]toxic effects were noted after accidental intravascular administration of racemic bupivacaine which were attributed to the dextro (R+) enantiomer.[9] Thereafter, levobupivacaine, the pure s-enantiomer of bupivacaine emerged as a safer alternative with similar clinical profile as racemic bupivacaine & better safety profile.[10]

Several studies have demonstrated & explained the mechanism of toxicity of bupivacaine.[10,11] Bupivacaine has been shown to cause indirect depression of cardiac conduction (AV conduction, QRS complex) & contractility by blocking mainly inactivated state of sodium channels.[12] Studies demonstrate dextro (R+) enantiomer has 2.4 times higher affinity for cardiac sodium channels & dissociates from it slowly as compared to levo (S+) enantiomer.[12,13] This explains the higher cardiac toxicity of racemic bupivacaine as compared to its levo isomer. Also, levobupivacaine causes less rapid blockade of the cell firing in nucleus tractus solitaries (NTS)[11] which explains its lower CNS toxicity compared to racemic bupivacaine. One more factor for difference in toxicity between the two enantiomers can be explained on the basis of their pharmacokinetics. The protein binding of levobupivaine is >97% as against 95% in case ofbupivacaine. This means <3% of levo is free in plasma to have action on other tissues causing undesired toxic effect.[9,10,13]

The above studies prove that levobupivacaine has a better safety profile than its racemic mixture. We therefore chose to study and compare the effectiveness of racemic bupivacaine & levobupivacaine for supraclavicular brachial plexus block. In this prospective observational study, we compared the effectiveness of bupivacaine versus levobupivacaine for supraclavicular brachial plexus block. A total number of 60 patients in the age group of 18 –60 years were included in the study. The study population was divided into 2 groups with 30 patients in each group. Both the groups were comparable with respect to age, gender, weight & ASA grade.

The onset time of sensory block was assessed by diminished response to pinprick in C5-T1 dermatome. The mean onset time of sensory block was 12.48±3.83 minutes in the bupivacaine group and 10.13±2.34 minutes in the levobupivacaine group. This shows that the onset of sensory block is significantly faster with levobupivacaine as compared to bupivacaine.

JyotiPushkar Deshpande et al[14] evaluated and compared the differences in onset of sensory blockade of racemic bupivacaine versus levobupivacaine in supraclavicular brachial plexus block. They found that the onset of sensory block was earlier with levobupivacaine as compared to bupivacaine which was statistically significant. (P<0.001)

Jose Ricardo Pinotti Pedro et al[15], 2009, found that the onset of sensory blockade was faster in the levobupivacaine group and the difference was statistically significant. (p<0.05)

Cacciapuoti et al[16], 2002, compared the clinical profiles of levobupivacaine, racemic bupivacaine and ropivacaine at equipotent doses in axillary brachial plexus block in the orthopaedic surgery of wrist and hand. They found that the onset of sensory block was faster with levobupivacaine as compared to bupivacaine.

FüsunEroğlu et al[17] carried out a study to investigate whether there is significant difference between the block of morphine adjuncted bupivacaine and levobupivacaine in axillary perivascular brachial plexus block. They found that the onset of sensory block was faster with levobupivacaine than bupivacaine and the difference was statistically significant (p<0.0001).

Our findings are in concordance with these studies. However, in the study conducted by Cenk Ilham[18] et al, the onset of sensory block was faster with bupivacaine while Cox CR et al[19] found no difference in the onset times between the two groups.

The duration of sensory block was assessed by return of pinprick sensation in C5-T1 dermatome. The mean duration of sensory block was higher in the levobupivacaine group i.e. 1034.5±146.65 minutes versus 881.4±124.45 minutes in the bupivacaine group.

The results of our study are in concordance with the results of JyotiPushkar Deshpande et al.[14], Cacciapuoti et al[16]&Charu J Pandya et al. However, we differed from Cenk Ilham et al[18] and Cox CR et al[19] who found no significant difference between the two groups. The onset of motor block was the time from injection of the drug to inability to flex the forearm or wrist. We found a statistically significant difference in the mean onset time of motor block between bupivacaine (14.1±3.85 minutes) and levobupivacaine (11.92±2.29 minutes). On the contrary, in a study conducted by Cink Ilham et al[18], the onset was faster with bupivacaine (19.64±10.70 minutes) as compared to levobupivacaine (25.66±10.72 minutes). However, our results were similar to JyotiPushkar Deshpande et al[14]. (p<0.001) and Cacciapuoti et al[16].

Although there was a statistically significant difference in the onset of sensory and motor block in the bupivacaine group, we believe that this may not make much of a difference clinically.

The time from onset of motor block to ability to flex the forearm or wrist was considered as the duration of motor block. The duration of motor block was 936.83±116.45 minutes in the bupivacaine group and 1109.17±146.33 minutes in the levobupivacaine group. This shows that the duration of motor block was significantly prolonged in the levobupivacaine group. Similarly, Jyoti Pushkar Deshpande et al.[14], 2014 found the duration of motor block with

levobupviacaine to be 1048.32±97.24 minutes and that with bupivacaine to be 900.41±177.74 minutes. Cacciapuoti et al[16], 2002 also found a significantly prolonged duration of motor block with levobupivacaine.

Levobupivacaine has vasoconstrictor action as demonstrated in Aps Reynolds[20] study which could explain the prolonged duration of action. However, in surgeries where early return of motor activity is desired, it may not be a suitable choice.

Duration of analgesia was considered as the time taken to reach an NRS score of 3 &rescue analgesia was given at this time. The duration of analgesia was 909±122.24 minutes in the bupivacaine group and 1073.8±147.44 minutes in the levobupivacaine group i.e. it was prolonged in the levobupivacaine group and the difference was statistically significant. Prolonged duration of analgesia could also be due to prolonged action of levobupivacaine due to its vasoconstrictor action as concluded by Aps Reynolds et al.[20] On the contrary, in the study conducted by Cline et al[21], duration of analgesia with levobupivacaine was less (833 minutes) as against 1048.32 minutes in our study. This difference could be attributed to the difference in technique, as brachial plexus block in their study was given by the transaxillary approach. Our findings corroborated the results of JyotiPushkar Deshpande et al.[14], 2014 and Cacciapuoti et al[16], 2002. ($p<0.001$)

We did not find any incidence of adverse effects like hemodynamic instability, local anesthetic toxicity, cardiac arrhythmias, pneumothorax etc. in either group.

In Cox et al[19] study, one patient developed CVS and CNS toxicity while another complained of chest pain and JP Badheka et al[22] observed convulsions in one patient.

The limitation of our study is the small number of cases. Though our results suggest that levobupivacaine is faster acting and has a prolonged duration of action; to obtain a definite result, a larger sample size would be required. We included patients with ASA I&II physical status only. Inclusion of high-risk patients would be needed to justify the superior safety profile of levobupivacaine over that of bupivacaine.

SUMMARY

This prospective observational study was conducted to compare the effectiveness of bupivacaine versus levobupivacaine for supraclavicular brachial plexus block using nerve stimulator in 60 patients of either sex, aged 18 – 60 years, ASA grade I and II, undergoing upper limb surgeries.

Study population was divided into 2 groups of 30 each where group B received bupivacaine (20ml, 0.5%) + lignocaine (2% adrenalized) and group L received levobupivacaine (20ml,0.5%) + lignocaine (2% adrenalized).

The onset and duration of sensory and motor block were compared. It was observed that onset of sensory block with levobupivacaine was 10.13±2.34 minutes as compared to that of bupivacaine which was 12.48±3.83minutes.

The onset of motor block was faster in the levobupivacaine group (11.92±2.29 minutes) as compared to bupivacaine (14.1±3.85 minutes).

In the levobupivacaine group, duration of sensory block was 1034.5±146.65 minutes while that in the bupivacaine group was 881.4±124.45 minutes.

Similarly, the duration of motor block was also more prolonged in the levobupivacaine group (1109.17±146.33 minutes) as compared to the bupivacaine group (936.83±116.45 minutes).

There was no difference in the hemodynamic profile between the two groups. Levobupivacaine has the added advantage of prolonged duration of analgesia (1073.8±147.44 minutes) compared to racemic bupivacaine (909±122.24 minutes).

Thus, our study shows the levobupivacaine is more efficacious than racemic bupivacaine and it would be a reasonable choice over bupivacaine in upper limb surgeries. Moreover, it may be be preferred over bupivacaine in high risk patients since it is known to have better safety profile.

CONCLUSION

We conclude that levobupivacaine has a faster onset of both sensory and motor blockade as compared to racemic bupivacaine. Also, the duration of both sensory and motor block is longer with levobupivacaine. The hemodynamic profile of both drugs was similar and we did not find any adverse effect with either drug.

In peripheral nerve blocks where large volumes of local anaesthetic is required, levobupivacaine seems to be a suitable choice since it is known to have less toxic potential.

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