International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 13, No. 10, October 2024 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_13.10.2024.56

Original Research

Comparative Evaluation of Levobupivacaine 0.5% and Ropivacaine 0.5% in Axillary Brachial Plexus Block for Below Elbow Surgeries

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Received Date: 29 August 2024 Accepted Date: 30 September 2024

Abstract:
Background: Brachial plexus block is a widely used regional anaesthesia technique for upper limb surgeries. Levobupivacaine and Ropivacaine are two popular local anesthetics used for this purpose.**Objectives:** To compare the onset and duration of sensory and motor block, duration of analgesia, and side effects of Levobupivacaine 0.5% and Ropivacaine 0.5% in axillary brachial plexus block.**Methods:** This prospective, randomized, double-blind study included 94 patients (18-60 years, ASA I & II) scheduled for elective below elbow surgeries. Patients were divided into two groups (n=47 each) and received either 20ml of 0.5% Levobupivacaine or 0.5% Ropivacaine. Onset and duration of sensory and motor block, duration of analgesia, and side effects were recorded.**Results**: Levobupivacaine had a faster onset of sensory block (11.40±2.223 min) compared to Ropivacaine (13.06±2.532 min) (p=0.001). Duration of analgesia and motor block were significantly longer with Levobupivacaine (627.13±66.002 min and 692.77±68.078 min, respectively) compared to Ropivacaine (508.72±60.194 min and 620.00±74.971 min, respectively) (p<0.001). No significant difference was observed in side effects between the groups.**Conclusion:** Levobupivacaine 0.5% has a faster onset of sensory blockade and longer duration of analgesia and motor block compared to Ropivacaine 0.5% in axillary brachial plexus block.

Keywords: Levobupivacaine, Ropivacaine, Axillary Brachial Plexus Block, Regional Anesthesia, Upper Limb Surgeries.

Introduction

Regional anesthesia involves numbing a large, selective area of the body by using local anesthetics.[(1)]Peripheral nerve blocks are frequently used for extremity surgeries for severe intra-operative and post-operative pain relief. It provides sympathetic blockade, better analgesia peri-operatively and cuts down on opioid requirement. It is superior to general anesthesia in various aspects like avoidance of respiratory tract instrumentation, reduction of recovery time and economic cost and improved patient satisfaction. [(2,3)]

Brachial plexus block is a mainstay for upper limb surgeries. The plexus is formed from C5 to T1 nerve roots. It is an effective method to provide anesthesia from shoulder to the tip of fingers using different approaches depending upon the type of surgery. Thorough knowledge of brachial plexus anatomy is an essential pre-requisite before administering brachial plexus block.Different approaches of brachial plexus block include interscalene, supraclavicular, infraclavicular and axillary. Different methods have been used for localising the nerve so as to administer a successful brachial plexus block. Typically, paresthesia

DOI: 10.69605/ijlbpr_13.10.2024.56

technique has been used. Other techniques like facial "pops", field infiltration or trans-arterial injection have also been used. Nerve stimulation by electric current or direct imaging with the help of ultrasonography, fluoroscopy, computed tomography (CT) and magnetic resonance imaging (MRI) require specific equipment and training to perform nerve blocks.[4] The risk of various complications decreases with the use of direct visualisation techniques as compared to blind techniques but when specific equipment is not available, the blind techniques are quite helpful and blocks become more popular and lead to the better localisation of nerves to be blocked and hence successful brachial plexus blocks.[5]

Bupivacaine is a commonly used local anesthetic for brachial plexus block due to its long-acting properties. It was noted that bupivacaine causes cardiac and central nervous system toxicity which wasdue to its dextro-enantiomer. This led to the isolation and use of levobupivacaine which has all the desirable effects of bupivacaine minus the toxic effects.[6-9] Ropivacaine is an S-enantiomer of S-1-propyl-2,6-pipecoloxylidide. It falls under amino-amide category of local anaesthetics whose chemical structureis similar to that of bupivacaine. Various comparative studies between ropivacaine and bupivacaine have shown that ropivacaine has a better cardiac and CNS profile than bupivacaine in terms of side effects while the analgesic properties are comparable with bupivacaine.[10-14]The present study was undertaken to observe and compare the effects of Levobupivacaine 0.5% and Ropivacaine 0.5% in Axillary Brachial Plexus block for below elbow surgeries.

Material and methods

The present study was conducted at L.N. Medical College & J.K. Hospital, Bhopal which is a tertiary health care centre with round the clock emergency services. 94 patients of age 18-60 years, ASA 1 & 2, admitted in the hospital and scheduled for below elbow surgeries were taken in this study after obtaining approval from the ethics committee. They were grouped in two groups by draw of lots, Group A and Group B. The patients were not aware of their group allotment.

A written informed consent was obtained from all willing participants and information sheet was provided regarding study. Patients were eligible for participation in this study if they met the inclusion criteria that comprisedpatients had to provide valid informed consent to participate. The study included adult patients of both sexes, aged 18-60 years. Additionally, patients had to have an American Society of Anesthesiologists (ASA) physical status classification of I or II. Furthermore, patients had to be scheduled for elective upper limb surgeries, specifically forearm and hand procedures.

Patients were excluded from participation in this study comprised patients who refused to participate. Additionally, patients with an American Society of Anesthesiologists (ASA) physical status classification of III or higher were not eligible. The study also excluded patients with a history of allergy to local anesthetics, as well as those with a history of alcohol or drug abuse, neurological disorders, or coagulation abnormalities. Patients requiring supplementation with general anesthesia, experiencing patchy or inadequate analgesia, or presenting with sepsis were also excluded. Furthermore, patients with compromised cardio-pulmonary profiles, multiple trauma, or acute spinal cord injuries were not considered eligible for participation.

The study consisted of two comparison groups, A and B, each comprising 47 participants. Group A received 20ml of 0.5% Levobupivacaine, while Group B received 20ml of 0.5% Ropivacaine.

The parameters studied and compared werethe onset and duration of sensory and motor block were assessed, along with the duration of analgesia. Additionally, potential side effects such as hypotension, cardiotoxicity, and neurotoxicity were monitored. Other vital signs and parameters recorded included pulse rate, blood pressure, respiratory rate, pulse-oximetry, and electrocardiogram (ECG) readings.

A routine pre-operative assessment was made the previous day including the airway and surface anatomy of the area where block was to be given. Appropriate premedication was given. In the operation theatre standard monitors were connected (Non-Invasive Blood Pressure (NIBP), Electrocardiogram and Pulse-Oximeter). 20 G intravenous cannula was inserted in the contra-lateral hand. Vital parameters were noted before performing the block. Appropriate equipment for procedure and drug related complications was kept ready before procedure. The Axillary brachial plexus block was given by an experienced anesthesiologist with the help of peripheral nerve stimulator after sterile preparation of site. The non-dominant hand was used to palpate and immobilize the axillary artery. With the patient in supine position, and the arm abducted and externally rotated, the terminal nerves usually lie in the following positions relative to the artery: Median nerve - superior, Ulnar nerve - inferior and Radial nerve - inferior posterior. 2-in, 22 gauge insulated needle was inserted proximal to the palpating fingers to elicit muscle twitches in the hand. Once an appropriate muscle response was identified and after reducing the stimulating current to less than 0.5 mA, careful aspiration was performed and local anesthetic was injected. (The needle concentrates electric current at its tip while the nerve stimulator emits current (0-5mA) at intervals of 1-2 Hz). Study parameters were recorded as per definition. If both sensory and motor blocks were

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obtained within 30 minutes, it was considered as complete block. Vital parameters were noted every five minutes for first thirty minutes and thereafter every ten minutes till the end of surgery. Patients were given oxygen by face mask. Side effects were recorded and treated accordingly.

For statistical analysis continuous variables were summarized as mean and standard deviation whereas nominal/categorical variables as proportion (%). Parametric test i.e. Student's unpaired t-test was used for comparison of continuous variables and Chi-square test was used for nominal/categorical variables. The 'p' value was considered significant when it was <0.05. The statistical calculations were completed by using computer software known as SPSS – version 25 (Statistical Package for Social Science).

Results

Table 1: Comparing mean age and weight

Group Statistics					
	Group	N	Mean	Std. Deviation	P value
Age (year)	Levobupivacaine	47	34.53	13.304	0.791
	Ropivacaine	47	35.30	14.636	
Weight (kg)	Levobupivacaine	47	59.85	10.097	0.177
	Ropivacaine	47	62.57	9.287	

Table 1 shows the comparison of mean age and weight between groups. No significant difference was obtained in mean age of patients receiving Levobupivacaine (34.53±13.304 years) and those receiving Ropivacaine (35.30±14.636 years) as revealed by the insignificant p value of 0.791. Similarly, no significant difference was obtained in mean weight of patients receiving Levobupivacaine (59.85±10.097 kgs) and those receiving Ropivacaine (62.57±9.287 kg) as revealed by the insignificant p value of 0.177.

Table 2: Comparing mean pulse and mean MAP between groups

Time	Mean pulse rate					Mean MAP				
	Levobupivacaine		Ropivacaine		P value	Levobupivacaine		Ropivacaine		P value
	Mean	Std. Deviation	Mean	Std. Deviation		Mean	Std. Deviation	Mean	Std. Deviation	
Pre	80.00	8.531	80.79	9.838	0.679	94.13	9.782	92.09	8.361	0.279
5min	79.91	7.575	79.91	8.211	1.000	93.00	9.598	91.70	7.003	0.456
10 Min	80.23	7.642	77.89	6.407	0.111	93.11	10.186	89.85	7.009	0.074
15 Min	79.55	7.683	78.09	6.534	0.121	92.26	9.483	88.70	6.865	0.040
30 min	79.57	7.261	78.45	6.833	0.216	91.47	7.975	88.68	7.274	0.080
60 min	78.68	7.372	78.72	7.321	0.154	91.34	7.388	88.81	6.402	0.079
120 min	78.21	6.779	79.68	7.268	0.117	90.00	7.636	88.00	6.461	0.174
180 min	78.72	7.339	79.91	6.940	0.211	90.19	8.224	88.72	6.698	0.345
300 min	79.34	7.060	79.79	7.034	0.316	90.40	7.368	88.83	6.044	0.260
420 min	80.57	6.483	80.15	7.138	0.451	90.02	7.023	88.21	7.301	0.224
540 min	79.89	6.618	79.23	6.828	0.561	90.49	6.487	89.36	6.539	0.403

Table 2 shows the comparison of mean pulse and mean MAP between groups. Mean pulse between those receiving Levobupivacaine and Ropivacaine was similar across the time lines as revealed by the insignificant p value of more than 0.05.Mean MAP between those receiving Levobupivacaine and Ropivacaine was similar across the time lines as revealed by the insignificant p value of more than 0.05.

DOI: 10.69605/ijlbpr_13.10.2024.56

Table 3: Comparing mean Systolic blood pressure (SBP)and Diastolic blood pressure (DBP) between groups

Time	Systolic blood pressure (SBP)					Diastolic blood pressure (DBP)				
	Levobupivacaine		Ropivacaine		P value	Levobupivacaine		Ropivacaine		P value
	Mean	Std. Deviation	Mean	Std. Deviation		Mean	Std. Deviation	Mean	Std. Deviation	
Pre	126.23	10.738	122.94	9.102	0.112	77.83	9.863	77.13	8.659	0.715
5min	125.70	11.436	124.98	8.616	0.078	76.64	9.962	76.49	7.120	0.934
10 Min	124.30	12.439	123.87	8.492	0.147	77.04	10.467	75.26	7.185	0.337
15 Min	123.49	10.626	124.45	7.934	0.211	76.36	10.227	73.98	7.479	0.200
30 min	122.85	9.005	123.64	7.248	0.314	75.19	8.548	73.74	8.266	0.406
60 min	123.70	7.704	124.53	6.912	0.281	75.04	8.270	74.06	7.458	0.548
120 min	123.11	8.199	124.98	7.685	0.614	73.89	8.913	72.32	6.910	0.341
180 min	121.70	8.097	120.30	7.428	0.636	74.19	9.107	74.72	7.201	0.754
300 min	122.77	8.916	121.06	7.323	0.430	74.36	8.082	73.81	6.486	0.715
420 min	120.57	13.708	120.34	8.385	0.643	73.43	7.392	73.60	7.720	0.913
540 min	122.72	7.598	121.15	7.187	0.621	74.00	7.259	75.13	7.210	0.452

Table 3 shows the comparison of mean SBP and DBP between groups. Mean SBP between those receiving Levobupivacaine and Ropivacaine was similar across the time lines as revealed by the insignificant p value of more than 0.05.Mean DBP between those receiving Levobupivacaine and Ropivacaine was similar across the time lines as revealed by the insignificant p value of more than 0.05.

Table 4: Comparing mean SPO2 between groups

Time	Levobupivacaine		Ropivacaine		P value
	Mean	Std. Deviation	Mean	Std. Deviation	
Pre	99.30	0.805	99.32	0.726	0.893
5min	99.47	0.654	99.34	0.635	0.340
10 Min	99.68	0.471	99.43	0.683	0.038
15 Min	99.23	0.516	99.49	0.547	0.290
30 min	99.21	0.690	99.32	0.615	0.452
60 min	99.36	0.764	99.57	0.617	0.141
120 min	99.60	0.538	99.53	0.584	0.583
180 min	99.60	0.538	99.62	0.534	0.848
300 min	99.40	0.534	99.64	0.529	0.295
420 min	99.53	0.620	99.57	0.580	0.732
540 min	99.57	0.617	99.55	0.544	0.860

Table 4 shows the comparison of mean SPO2 between groups. Mean SPO2 between those receiving Levobupivacaine and Ropivacaine was similar across the time lines as revealed by the insignificant p value of more than 0.05.

DOI: 10.69605/ijlbpr_13.10.2024.56

Table 5: Comparing onset of sensory block between groups

	Group	N	Mean	Std. Deviation	P value
Onset of sensory block (min)	Levobupivacaine	47	11.40	2.223	0.001
	Ropivacaine	47	13.06	2.532	
Onset of motor block (min)	Levobupivacaine	47	19.02	2.409	0.595
	Ropivacaine	47	18.74	2.617	
Duration of analgesia (min)	Levobupivacaine	47	627.13	66.002	<0.001
	Ropivacaine	47	508.72	60.194	
Duration of motor block (min)	Levobupivacaine	47	692.77	68.078	<0.001
	Ropivacaine	47	620.00	74.971	

It was found that mean onset of sensory block was earlier in those receiving Levobupivacaine (11.40±2.223 min) as compared to those receiving Ropivacaine (13.06±2.532 min). The comparison was highly significant with p value of 0.001.Onset of motor block was similar with both the drugs that is Levobupivacaine (19.02±2.409 min) and Ropivacaine (18.74±2.617 min) as revealed by the insignificant p value of 0.595.It was found that duration of analgesia was significantly higher with Levobupivacaine (627.13±66.002 min) as compared to those receiving Ropivacaine (508.72±60.194 min) as revealed by the highly significant p value of <0.001.Duration of motor block was significantly higher with Levobupivacaine (692.77±68.078 min) as compared to Ropivacaine (620.00±74.971 min) as revealed by the highly significant p value of <0.001.

Table 6: Comparing side effects between groups

			Group		Total	P value
			Levobupivacaine	Ropivacaine		
Side effect	None	Count	46	45	91	0.682
		%	97.87%	95.74%	96.80%	
	Paresthesia	Count	1	1	2	
		%	2.13%	2.13%	2.12%	
	Dizziness	Count	0	1	1	
		%	0.0%	2.13%	1.06%	
Total		Count	47	47	94	
		%	100.0%	100.0%	100.0%	

Table 6 shows the comparison of side effects between groups. No significant difference was observed in terms of side effects between the groups as revealed by the insignificant p value of 0.682.

Discussion

Upper limb surgeries were usually performed in general anesthesia before regional anesthesia replaced the practice. Opioid-related side-effects like nausea, vomiting and sedation are also avoided with regional anesthesia. Avoidance of airway instrumentation, decrease in post-operative gravity of care, reduced recovery time and improved patient satisfaction[(1)]. Axillary brachial plexus block is a very effective technique for surgeries below the elbow. The use of peripheral nerve stimulator makes it easier to administer the block and ensures a higher success rate with less risk of side effects as compared to other techniques of administering the block.

We used the two comparatively newer drug preparations, Levobupivacaine and Ropivacaine which have gained popularity due to a better safety profile as compared to bupivacaine while giving the same analgesic duration. There have been few studies comparing the two drugs in brachial plexus block, even fewer studies for axillary approach have been done.

In our study we found that the onset of sensory block was significantly faster for Levobupivacaine (11.40±2.223 min) as compared to Ropivacaine whose onset of sensory block was slower (13.06±2.532 min). A study by R Mageswaran, Y C Choy showed similar result in infraclavicular brachial plexus block using 30 ml of 0.5% ropivacaine and 0.5% levobupivacaine.[(15)]A similar study was conducted by RalteLalrinmawia et al in supraclavicular block where 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.[(16)] Our result was also supported by the study of Kulkarni SB et al 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).[(17)]Liisanantti O, Luukkonen J, Rosenberg PH found similar onset in both the drugs for sensory

DOI: 10.69605/ijlbpr_13.10.2024.56

blockade.[18] Similar findings were noted by Casati et al, who demonstrated that 30 ml of 0.5% levobupivacaine produced similar onset and quality of block as the same volume of 0.5% ropivacaine in interscalene brachial plexus block.[19]

The onset of motor blockade in our study was similar for Ropivacaine (18.74±2.617 min) and Levobupivacaine (19.02±1.409 min) as shown by the insignificant p value of 0.595. In the study conducted by Lalrinmawia et al in supraclavicular block it was found that the onset time (mean) of motor block was faster in Levobupivacaine group (11.26 ± 1.61 minutes) when compared to Ropivacaine group (14.26 ± 1.72 minutes).[16] Similar findings were observed by Mageswaran R and Choy YC and Kulkarni SB et al.[15,17] Study conducted by Suzana Gonzalez-Suarez showed that the onset of motor block was faster with 0.33% Ropivacaine as compared with 0.5% Levobupivacaine in axillary brachial plexus block.[20] One possible explanation to this finding could be the lesser concentration of ropivacaine. Different studies have found variable results regarding the onset of motor block with ropivacaine and levobupivacaine.

The duration of analgesia and motor blockade was found to be more in Levobupivacaine than Ropivacaine. The duration of analgesia was significantly higher with Levobupivacaine (627.13±66.002 min) as compared to those receiving Ropivacaine (508.72±60.194 min) as revealed by the highly significant p value of <0.001. Similarly, the duration of motor blockade was significantly higher with Levobupivacaine (692.77±68.078 min) as compared to Ropivacaine (620.00±74.971 min) as revealed by the highly significant p value of <0.001.

LT Erik Cline et al in their study found that the duration of sensory block with levobupivacaine was 831 minutes as compared to 642 minutes with ropivacaine.[21] The longer durations of sensory and motor blockade could be attributed to the use of 40ml of 0.5% levobupivacaine and ropivacaine along with addition of 1:200000 epinephrine. The investigation by Cox and colleagues examining the differences between levobupivacaine and bupivacaine for axillary brachial plexus blockade, found similar results.[22] The duration of analgesia of levobupivacaine in our investigation was 627 minutes as compared with 1,039 minutes found by **Cox et al**. The longer duration in their study is because of the large volume they used (40ml). The duration of analgesia provided by ropivacaine by **McGlade et al** was 430 minutes as compared to 508 minutes in our study.[23] Both the studies used peripheral nerve stimulator technique. In our study there was difference in sensory block and motor block duration for levobupivacaine, such that the duration of motor block was slightly longer than the duration of sensory block. This is in concordance with the study done by **Cox et al**.[22] The duration of motor block in ropivacaine was also greater than the duration of sensory block. This is in contrast to the study conducted by **McGlade et al** which showed nearly identical times for sensory and motor blockade for ropivacaine.[23]

The side effects were observed in total 3 patients. 2 patients complained of paresthesia, 1 in each group and 1 patient who received ropivacaine complained of dizziness. In the studies conducted in the past comparing bupivacaine and levobupivacaine, it was found that levobupivacaine had a lower risk of CNS and cardiovascular toxicity than bupivacaine.[9,24-26]

Similarly in the studies conducted comparing bupivacaine and ropivacaine it was found that ropivacaine had similar analgesic potency as bupivacaine but was much less cardiotoxic[10,27-28]. Overdose of ropivacaine was better tolerated than overdose of bupivacaine. It still has the potential to cause CNS toxicity but the dose required for that is much greater than that of bupivacaine.[10]

The limitations of this study are as it was a single centre study and a small sample size was taken thus we could not study a variety of cases.The actual duration of sensory and motor blocks was not evaluated by electromyography or nerve conduction velocity.

Conclusion

From this study it was concluded thatlevobupivacaine has faster onset of sensory blockade as compared to ropivacaine. The onset of motor blockade is similar for both levobupivacaine and ropivacaine. The duration of analgesia and duration of motor blockade were much longer for levobupivacaine than for ropivacaine and the duration of motor blockade was longer than that of sensory blockade for both the drugs.

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