Research Article

A comparative study of 0.5% ropivacaine and 0.5% levobupivacaine in supraclavicular brachial plexus block

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Abstract

Background: To compare the clinical profiles of levobupivacaine and ropivacaine at equipotent doses for supraclavicular brachial plexus block for upper limb surgeries, we hypothesized that both will induce a similar upper limb anesthetic blockade in terms of sensory and motor blockades.

Objective: To evaluate the effects of levobupivacaine and compare it with ropivacaine in brachial plexus block through supraclavicular route**.**

Materials and Methods: For this prospective study, 60 patients of both sexes ASA I/II were enrolled and divided into two groups, and supraclavicular brachial plexus block was performed using levobupivacaine 0.5% and ropivacaine 0.5% using classical approach. The onset of sensory and motor block, their duration, and possible adverse events were recorded.

Result: No statistically significant difference was observed in the onset of sensory block in both the groups. Onset of motor blockade was significantly faster with ropivacaine (9.50 ± 2.403 min) as compared to levobupivacaine (12.33 ± 2.537 min; $P < 0.05$). Duration of sensory and motor block was significantly short for ropivacaine than levobupivacaine ($P < 0.05$). Levobupivacaine has significantly longer duration of analgesia (12.56 ± 1.30 h) as compared to ropivacaine (9.93 ± 1.7 h; $P < 0.05$).

Conclusion: Levobupivacaine, a novel long-acting local anesthetic agent, having better profile in terms of duration of analgesia, with a considered disadvantage of delayed wearing off of motor blockade, offers an alternative to ropivacaine for brachial plexus block in upper limb surgeries.

KEY WORDS: brachial plexus block, levobupivacaine, ropivacaine, upper limb

Introduction

Regional anesthesia techniques are an important part of the armamentarium of an anesthesiologist. The widely accepted mechanism of all-inclusive anesthetic care is the peripheral neural blockade. Brachial plexus block forms the multipurpose and dependable local anesthesia technique. The supraclavicular route of brachial plexus blockade provides anaesthesia of the whole upper extremity in the most constant, time-effective manner of the various brachial plexus technique that blocks the roots of brachial plexus. The axillary approach offers lesser area of anesthesia than supraclavicular, tendency to produce "patchy" blocks, and low overall success rate and an increased incidence of tourniquet pain during prolonged surgery. The interscalene approach is difficult to master as there is a high degree of intrathecal, epidural, and intra-arterial injection. It also causes phrenic nerve and recurrent laryngeal nerve paralysis along with Horner's syndrome. Bupivacaine is frequently used as local anesthetic agent for brachial plexus block because of its favorable ratio of sensory to motor neural block and longer duration of

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action with disadvantage of cardiac and central nervous system (CNS) toxic effects in some patients attributed to dextrobupivacaine enantiomer. Ropivacaine is also an amino-amide local anesthetic with structure similar to bupivacaine. It produces less cardiac and CNS toxicity, with less motor blockade and similar sensory block when compared with bupivacaine. However, latency of sensory analgesia was about two-thirds that of bupivacaine and not effective for prolonging postoperative analgesia. Levobupivacaine is the latest local anesthetic introduced. It has been shown to be safe and effective for spinal and epidural anesthesia and brachial plexus blockade. According to previous studies, it has effect similar to bupivacaine with an advantage of lesser cardiac and CNS toxicity. Only few trials have been conducted in order to compare the effects of ropivacaine and levobupivacaine to come to a conclusion for a better choice between the two for brachial plexus block. Our working hypothesis (null hypothesis) is that, when the same volume and concentration of prescribed anesthetics is administered to brachial plexus via supraclavicular route, both should induce a similar upper limb anesthetic blockade in terms of sensory and motor blockades.

Objective

The aim of our study was to evaluate the effects of levobupivacaine and compare it with ropivacaine in brachial plexus block through supraclavicular route.

Parameters of comparison:

1. Onset and duration of sensory block
2. Onset and duration of motor block
3. Duration of analgesia
4. Hemodynamic parameters
5. Complications

Materials and Methods

A total of 60 patients aged between 18 and 65 years with ASA I/II physical status admitted for any kind of orthopedic or plastic surgeries on upper limb were included in the comparative study after approval by the institutional ethics committee.

Exclusion criteria were as follows:

1. Patient's refusal
2. Allergy to amide group of local anesthetic agent
3. Contraindication to brachial plexus block
4. Significant neurological disease in upper limb
5. Renal disease and psychiatric history
6. Inability to comply with study assessment
7. Pregnancy and lactation
8. Patient on anticoagulants or bleeding disorder
9. Underlying other significant systemic disease.

The subjects were divided into two groups: group A, Inj. Ropivacaine (0.5% 30 mL) and group B, Inj. Levobupivacaine (0.5% 30 mL).

Brachial plexus blockade was performed through supraclavicular approach using classical technique (Kulenkampff approach). Heart rate, blood pressure, and oxygen saturation were recorded before the procedure and at 5, 10, 15, 30, 45, 60, 90, and 120 min, and then every 2 hourly postoperatively till the complete wearing off of the effect.

Onset of sensory block was assessed every 2 min by atraumatic pinprick test in the areas innervated by radial, ulnar, and median nerves and compared with the same stimulation on contralateral hand.

Sensory blockade was graded as: grade 0 (no block), normal sensitivity; grade 1 (onset), reduced sensitivity compared with same territory in contralateral upper limb; grade 2 (partial), analgesia or loss of sharp sensation of pinprick; and grade 3 (complete), anesthesia or loss of sensation to touch.

- Onset time was defined as the time from injection of drug to a dull sensation on any of the nerve distribution.
- Sensory peak effect time is defined as the time from injection of drug to complete loss of sensation along all the nerve distributions.
- Duration of sensory block was defined as the time between the peak effect time and feeling of dull sensation in any of the nerve distribution.
- Onset of wearing off of sensory block starts from feeling of dull sensation in any of the nerve distribution.
- Complete wearing off of sensory block is defined as sharp pain felt in all the nerve distributions.

Motor block was evaluated by four-point scale: grade 0, no block; grade 1 (onset), decreased movement with loss of strength; grade 2, (partial): decreased movement with inability to perform movement against resistance; and grade 3 (complete), paralysis.

- Onset time was considered from the injection of drug to patient felt heaviness on abduction of arm at shoulder.
- Motor peak effect time was from the injection of drug to absence of any voluntary movement at the level of arm and forearm.
- Duration of motor blockade was defined as between the onset of peak motor effect and the onset of weaning of motor effect in any of the nerve distribution.
- Onset of wearing off of motor blockade is the time when reduced movement of fingers and wrist is present.
- Complete wearing off of motor blockade is the time when complete movement of wrist and fingers return.

Patients were observed for any systemic side effects such as bradycardia, hypotension, and so on. Intraoperative data were recorded at every 15- to 30-min interval. Tourniquet inflation, deflation time, and duration of surgery were noted.

The intensity of postoperative pain was evaluated using visual analog scale (VAS) with grade 0 (no pain) to 10 (worst pain). Pain score were noted every 5 to 10 min initially and then hourly till the patient regain VAS score of 4. Analgesia was considered satisfactory if the score was 3 or less. If the score was more than 4, analgesia was judged unsatisfactory, rescue analgesia was administrated, and the time for need of first analgesia was noted. Evaluation was stopped when complete wearing off of the effect occurred. Both the groups were

compared for duration of analgesia (time between the end of local anesthetic administration and the first analgesic request made), duration of sensory block (time between the sensory peak effect time and feeling of dull sensation in any of the nerve distributions), and duration of motor block (time from the onset of peak motor effect to onset of weaning of motor block in any nerve distribution). Vital parameters were noted at regular intervals along with pain scored for 16 h.

Statistical Analysis

All the data were filled up in pro foma and were statistically analyzed by applying *Z* test for analysis in both the groups for various parameters. The results were considered significant if *P* value is <0.05 and highly significant if *P* value is <0.001.

Results

After studying 60 cases, the observation and results were summarized in tabulated form. All the patients were divided into two groups with 30 patients in each group ($n = 30$): group A, Inj. Levobupivacaine (0.5%, 30 mL) and group B, Inj. Ropivacaine (0.5%, 30 mL).

Table 1 shows the distribution of patients according to mean age and mean weight with standard deviation and sex incidence of patients in both the groups with no significant difference. Table 2 shows different types of surgery. Table 3 shows the mean duration of surgery in minutes with standard deviation in both the groups with no significant difference. The maximum duration of surgery was 120 min.

Table 4 shows the mean onset time of sensory blockade and motor blockade in minutes in both the groups. Sensory onset time was calculated from time of injection of drug to onset of dull sensation on any of the nerve distribution. Motor onset time was calculated from time of injection of drug to when patient felt heaviness on abduction of arm at shoulder. Sensory onset time was almost similar in both groups with $P > 0.05$, which was not significant, while motor onset time was longer in levobupivacaine group compared with ropivacaine with $P < 0.05$, which was statistically significant.

Table 5 shows the duration of sensory block, motor block, and duration of analgesia with standard deviation in minutes. Duration of sensory block was calculated from the time between the peak effect time and feeling of dull sensation in any of the nerve distributions. It was longer in group A, i.e., levobupivacaine group, which was highly statistically significant ($P < 0.001$). Duration of motor block was calculated from the time between the onset of peak motor effect and the onset of wearing off of the motor effect in any of the nerve distributions. It was shorter with ropivacaine when compared with levobupivacaine and was statistically significant ($P < 0.05$).

The duration of effective analgesia was calculated from the time between the end of local anesthetic administration to the time when VAS was less than 4 and rescue analgesic was administered when VAS score was equal to or greater than 4 [Table 6]. It was significantly longer in group A when compared with group B for both the duration of effective analgesia and the time for rescue analgesia and was statistically significant ($P < 0.05$). At VAS score ≥ 4, rescue analgesia was given

Table 1: Demographic data

Variables	Group A (levobupivacaine)	Group B (ropivacaine)
Age (years)		
Mean	33.47	32.63
Standard deviation	12.21	12.48
Weight (kg)		
Mean	57.13	53.83
Standard deviation	7.66	7.53
Sex ratio		
M:F	22:8	20:10

Table 2: Type of surgery

	Arm	Forearm	Hand
Group A, *n* (%)	4 (13.3)	22 (73.3)	4 (13.3)
Group B, *n* (%)	5 (16.7)	22 (73.3)	3 (10)

Table 3: Duration of surgery

	Mean (min)	SD	*P*
Group A, $n = 30$	83.00	23.216	0.87
Group B, $n = 30$	82.00	22.190	

Table 4: Time for onset of sensory and motor block

	Sensory block onset time (min)		Motor block onset time (min)	
	Mean	SD	Mean	SD
Group A	11.67	2.397	12.33	2.537
Group B	11.17	2.520	9.50	2.403
P	>0.05		<0.05	

Table 5: Duration of anesthesia and analgesia

	Group A		Group B		*P*
	Mean	SD	Mean	SD	
Duration of sensory block (h)	10.93	1.363	8.67	1.093	<0.001
Duration of motor block (h)	10.87	1.137	7.13	1.252	<0.05**

**Significant.

Table 6: Analgesia

	Group	Mean (h)	SD	*P*
Duration of effective analgesia (VAS<4)	Group A	12.566	1.30	<0.001
	Group B	9.93	1.70	
Time of rescue analgesia (VAS ≥ 4)	Group A	14.66	1.422	<0.001
	Group B	11.93	1.617	

Table 7: Mean heart rate at different time interval

	0 min	5 min	10 min	15 min	30 min	45 min	60 min	90 min	2 h	4 h	6 h	8 h	10 h	12 h	14 h	16 h
Group A																
Mean	87.33	87.00	83.00	82.33	76.67	75.33	75.33	75.55	75.33	76.73	78.40	79.93	81.47	82.00	84.80	86.40
SD	8.548	7.348	7.874	7.421	7.339	7.339	7.339	7.339	7.339	6.674	6.734	6.422	5.847	5.356	5.346	4.966
Group B																
Mean	82.80	80.00	75.60	75.60	75.80	75.60	77.40	76.80	75.00	74.40	76.13	78.20	79.43	79.60	81.13	83.13
SD	7.155	5.657	3.847	3.847	6.181	8.295	7.339	5.933	6.403	5.184	4.392	5.467	5.077	5.418	5.818	5.374

Table 8: Mean blood pressure changes in groups at different interval

	0 min	5 min	10 min	15 min	30 min	45 min	60 min	90 min	2 h	4 h	6 h	8 h	10 h	12 h	14 h	16 h
Group A																
Mean	86.83	86.83	86.83	86.00	85.33	84.83	86.00	84.83	86.67	88.03	88.27	88.83	89.80	90.73	92.30	93.63
SD	9.390	9.390	9.390	8.76	8.65	8.25	7.334	8.25	7.334	6.759	6.853	6.094	6.354	6.258	6.433	7.379
Group B																
Mean	91.00	89.00	84.40	83.00	84.83	78.60	77.03	78.60	77.03	80.80	83.87	84.37	85.00	86.50	87.67	89.57
SD	8.367	8.944	8.67	8.68	8.25	7.021	5.774	7.021	5.774	5.041	5.746	5.423	6.550	6.372	6.970	5.793

Table 9: SpO_2 changes in groups at different time intervals

	0 min	5 min	10 min	15 min	30 min	45 min	60 min	90 min	2 h	4 h	6 h	8 h	10 h	12 h	14 h	16 h
Group A																
Mean	99.50	99.50	99.50	99.50	99.50	99.50	99.80	99.60	99.50	99.50	99.50	99.50	99.50	99.50	99.80	99.60
SD	0.548	0.548	0.548	0.548	0.548	0.548	0.447	0.548	0.548	0.548	0.548	0.548	0.548	0.548	0.447	0.548
Group B																
Mean	99.80	99.80	99.80	99.60	99.60	99.80	99.50	99.50	99.80	99.80	99.80	99.60	99.60	99.80	99.50	99.50
SD	0.447	0.447	0.447	0.548	0.548	0.447	0.548	0.548	0.447	0.447	0.447	0.548	0.548	0.447	0.548	0.548

(Inj. Diclofenac, 1–2 mg/kg i.v.). No significant changes was found in hemodynamic parameters between both the groups [Tables 7–9].

Complications

No significant intraoperative and postoperative complications such as pneumothorax, intra-arterial or intravascular placement of drug, nausea, vomiting, neurotoxicity, or cardiotoxicity were found in either group.

Discussion

Regional anesthesia offers enhanced satisfaction and cause lower cognitive damage and immunosuppression compared with general anesthesia, particularly in elderly patients, with added advantages such as early ambulation, reduction of blood loss of 20%–50% in various procedures, and attenuation of the hypercoagulable state associated with surgery.[10]

Brachial plexus block forms the multipurpose and dependable local anesthetic technique and an appropriate substitute to general anesthesia for upper limb surgery. The supraclavicular approach performed at trunk level provides the most complete and reliable anesthesia as it provides anesthesia of the entire upper extremity in the most consistent, time-efficient manner of many brachial plexus techniques for elbow, forearm, and hand surgery. All patients in our study were demographically similar in both the groups. No differences were seen in other studies too. Majority of the patients underwent surgical procedures such as K-wire, platting, nailing implant removal, and external fixator in upper limb and comparable in between the groups. Duration of surgery was also similar in both the groups and statistically not significant. In this study, the onset of sensory block was rapid with ropivacaine when compared with levobupivacaine, but the difference was statistically not significant ($P > 0.05$). In contrast, the onset of motor blockade was significantly faster with ropivacaine (9.50 ± 2.403 min) when compared with levobupivacaine (12.33 ± 2.537 min; $P < 0.05$). Most of the local anesthetics block C fibers at approximately the same rate, but the rate of blockade of A fiber depends on the physicochemical properties of the individual drugs such as pKa, lipid solubility, and so on. As ropivacaine is less lipid soluble, envisaging that it will block A fibers more slowly than levobupivacaine, equal volumes and concentrations of either drug produces a similar pattern of sensory block but the motor block is slower in onset, less in intensity, and shorter in duration with ropivacaine.[3] In one of the study by Mageswaran and Choy,[21] there was a greater onset time of sensory blockade and slower motor blockade with ropivacaine than levobupivacaine. In another study,[4] both sensory and motor onset times were faster with 0.75% ropivacaine (7.5 ± 1.2 min and 14.0 ± 2.3 min, respectively) when compared with 0.5% levobupivacaine (10 ± 2.4 min and 17 ± 5 min, respectively). Trend of onset of both block were similar to our study in both the groups. The difference in observations may be attributable to the anatomic location of the different nerve blocks, the technical procedure used, and the different methods used to observe parameters such as analgesia and anesthesia. In this study, ropivacaine (8.67 ± 1.093 h) showed significantly shorter duration of sensory block when compared with levobupivacaine (10.93 ± 1.363 h; $P < 0.001$).

The duration of motor block was significantly shorter with ropivacaine (7.13 ± 1.252 h) when compared with levobupivacaine (10.87 ± 7.13 h; $P < 0.05$). The trend of our results were similar to the study by Cline et al.[18] The durations of both the blocks, sensory and motor, were prolonged than our study group, which could be attributed to the addition of epinephrine in the study in comparison.

In one of the study,[17] reverse trend, viz. the duration of motor block and sensory block, was prolonged for ropivacaine when compared with levobupivacaine with statistical significance. In this study, levobupivacaine showed significantly longer duration of analgesia (12.56 ± 1.30 h) when compared with ropivacaine (9.93 ± 1.7 h; $P < 0.05$). In three of the studies,[2,17,18] similar trends of duration of analgesia was observed but the duration was longer when compared with our study in both the groups, which could be attributed to the different drug concentration used, the different method used to calculate duration of analgesia, and the interobserver differences. In the study by Gonzalez-Suarez et al.,[11] the duration of analgesia was seen to be prolonged with ropivacaine (11.3 ± 4.1 h) than with levobupivacaine (9.2 ± 3.1 h), which was reverse than our study, which could be because of higher concentration of levobupivacaine used in our study. In this study and other studies, the intraoperative pulse rate and systolic blood pressure remained stable without any significant fluctuation in both the groups. Rescue analgesic was given when the patient developed VAS score ≥ 4. There was a significant difference ($P < 0.05$) in time of rescue analgesia, viz. prolonged for levobupivacaine (14.66 ± 1.42 h) than for ropivacaine (11.93 ± 1.61 h). Mageswaran and Choy.[21] observed no significant difference in VAS score and, hence, the time for rescue analgesia in both the groups when compared with our study. Cline et al.[18] observed that the ropivacaine group showed slightly higher verbal numerical rating scale scores at 8th and 10th hour postoperatively. No such difference was found in our study. No significant intraoperative and postoperative complications such as pneumothorax, intra-arterial or intravascular placement of drug, nausea, vomiting, neurotoxicity, or cardiotoxicity were found in either group.

Conclusion

To conclude the study, we observed that levobupivacaine, a novel long-acting local anesthetic agent, having better profile in terms of duration of analgesia, with a considered disadvantage of delayed wearing off of the motor blockade, offers an alternative to ropivacaine for brachial plexus block in upper limb surgeries. Levobupivacaine should be considered when postoperative analgesia is a concern but not when an early return of motor activity is required.

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