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Comparison of bupivacaine and levobupivacaine in continuous axillary brachial plexus block

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ABSTRACT

Aims: This study compares bupivacaine – lidocaine and levobupivacaine – lidocaine administrations in terms of initiation and duration of motor and sensorial blockage, total number of additional analgesic applications, analgesic amount consumed in 24 hours, side-effects and hemodynamic effects in continuous axillary brachial pleksus block in hand and forearm surgery.

Methods: Thirty ASA I-II physical status patients, scheduled hand or forearm surgery were enrolled for of the two groups in a randomized study. Axillary catheter duly placed in both group with appropriate guided techniques. Patients in group B received 0.5% bupivacaine 20 ml+2% lidocaine 20 ml and group L received 0.5% levobupivacaine 20 ml+2% lidocaine 20 ml through the axillary catheter. Initiation and duration of motor and sensorial block, total number of additional analgesic applications and analgesic amount consumed in postoperative 24 hours were recorded. Pre-block, peri-operative and post-operative blood pressures and heart beat rates were also recorded. Block application duration, operation duration, tourniquet duration and demographic data of patients (age, sex, weight, and length) were recorded. Demanded and applied analgesic doses by the patient controlled analgesia devices, side effects and complications were also recorded.

Results: There was no statistically significant difference between two groups in terms of initiation and duration of motor and sensorial block, amount of analgesic consumed in 24 hours, demanded and applied analgesic doses by the patient controlled analgesia devices and hemodynamic data ($p>0.05$). There is a mild and positive relation between block application duration and patient weight ($p=0.014$; $r=0.444$)

Conclusion: Both bupivacaine+lidocaine and levobupivacaine+lidocaine combinations can safely be used in axillary continuous brachial plexus block without any difference in terms of initiation and duration of block, total analgesic amount consumed. Their duration of action and effect on hemodynamic responses are similar.

Keywords: Axillary brachial plexus blockage, continuous brachial plexus block-age, bupivacaine, levobupivacaine

INTRODUCTION

Regional anesthesia continues to be a frequently used form of anesthesia in anesthesia practice. The fact that it has some advantages compared to general anesthesia increases its usability even more.[1] Regional anesthesia has advantages such as patient consciousness, avoidance of complications related to endotracheal intubation due to continuation of spontaneous breathing and preservation of airway reflexes, prevention of aspiration risk, early mobilization and recovery, postoperative pain control and early hospital discharge time.[2-4]

The suitability of the anatomy of the brachial plexus and its easy accessibility are the reasons for preference in anesthesia for orthopedic interventions in the upper extremity. In reconstructive surgery, vasodilation due to sympathetic blockade accompanying brachial plexus anesthesia significantly increases the incidence of surgical success.[5] Brachial plexus blockade can be performed with various techniques.

The aim of this study was to compare bupivacaine and levobupivacaine administration with continuous brachial plexus blockade via axillary approach in cases requiring hand and forearm surgery in terms of motor and sensory block onset, duration of block, total number of additional analgesic applications, 24-hour analgesic consumption, effects on hemodynamics and side effects.

METHODS

This study was conducted with the approval of the Ethics Committee of Ankara Clinical Researches Ethics Committee No. 1 (Date: 11.01.2010, Decision No: 2010/01/198) and written informed consent of the patients. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Thirty patients in the ASA I-II group aged 20-70 years who were planned to undergo upper extremity surgery were included in the study. Patients with known sensitivity to any of the drugs used in the study, peripheral neuropathy, non-cooperative, cutaneous infection at the procedure site, coagulopathy, history of cardiac, respiratory, hepatic or renal failure and patients who did not want to participate in the study also patients who proceeded to general anesthesia due to failed block were excluded. During the preoperative visit, all patients were physically examined, and laboratory findings were evaluated. Patient-controlled analgesia was initiated through a perineural axillary catheter.

Patients were divided into 2 groups with 15 patients in each group by closed envelope method: Group B (0.5% bupivacaine 20 cc/100 mg), Group L (0.5% levobupivacaine 20 cc/100 mg). (2% lidocaine 20cc 400 mg was used in both groups).

The patients were administered midazolam 0.05 mg/kg im as a premedication agent 30 minutes before surgery. Noninvasive arterial blood pressure (NIBP), electrocardiography (ECG) and peripheral oxygen saturation (SpO_2) monitoring were performed. O_2 was administered at 2 lt/min with a nasal cannula.

For axillary brachial plexus blockade, the forearm was flexed and externally rotated, and the hand was placed next to the head with the palm facing upwards. Axillary artery pulsation was taken, and its cross-section was drawn with a pencil. The axillary region was cleaned with povidion iodine solution and covered with sterile drape. The cathode pole of the nerve stimulator (Stimuplex® B Braun, Melsungen, Germany) was connected to the needle conductor tip and the anode pole to the ECG electrode placed on the inner side of the wrist of the arm to be blocked. The most proximal point where the axillary artery pulse was felt was palpated again, 2% lidocaine 2 ml of local anesthesia was administered to this point, and the skin and subcutaneous tissue was penetrated with a 22-gauge 50 mm short-bevelled peripheral nerve stimulator catheter set needle (Stimuplex®BBraun, Melsungen, Germany) from above the artery at an angle of approximately 45 to the skin. Stimulator stimulation frequency was set to 2 Hz and amplitude to 2 mA. During the insertion of the needle, entry into the axillary sheath was recognized by feeling the fascia click, paresthesia or oscillation of the released needle in accordance with the arterial pulse. The time of block was considered as the time from the introduction of the stimulator needle into the skin until the end of drug infusion.

The time of onset of sensory block was recorded as the time (min) when sensory block scale was 1 (Table 1) in any of the four nerves, that is, when pain disappeared but the sensation of touch persisted, and the time of sensory block was recorded as the time (min) when sensory block scale was 2 in all nerves, that is, when pain and tactile sensation disappeared.

The onset time of motor block was recorded as the time (min) when motor block scale was 1 (Table 1) in any of the four nerves, when the motor impulse was decreased but the arm was able to move, and the onset time of motor block was recorded as the time (min) when motor block scale was 3, complete block in all nerves.

Table 1. Sensory block and motor block onset and development times

	Group B (n=15)	Group L (n=15)	p
Sensory block onset time (min)	7.33±1.72	7.87±1.25	0.339
Motor block start time (min)	5.73±0.80	6.33±1.18	0.113
Sensory block development time (min)	15.67±2.26	16.07±1.62	0.582
Motor block development time (min)	13.33±2.26	14.80±1.70	0.054

Values are given as mean±standard deviation. p<0.05 was considered significant.

After the block was performed, patients were examined for sensory and motor block at 1-minute intervals.

Systolic (SBP), diastolic (DBP), mean arterial pressures (MAP), heart rate (HR) values were recorded before and 5, 10, 15 minutes after the block was performed. SBP, DBP, MAP, HR values were recorded intraoperatively at 1, 5, 10, 20, 20, 30, 40, 50, 60 minutes and postoperatively at 1, 2, 4, 6, 12 and 24 hours. The time of first analgesic requirement and the amount of analgesic consumed in the postoperative 24-hour period were documented.

Before starting the analyses, the compliance of the data with certain assumptions was investigated. In the comparison of means analyses, "Kolmogorov Smirnov Normality Test" was used to examine the conformity to normal distribution and "Levene Test Statistics" was used for the conformity of the homogeneous variance presumption. In the analysis of the relevant data, the test to be applied was decided by considering whether the assumptions were met and the structure of the data.

Independent Groups T Test was used to compare the two groups in terms of age, height, weight, block application time, number of demanded doses, number of administered doses, total amount of anesthetic, duration of anesthesia, tourniquet time and operation time. In the research of the relationship between these two patient groups and gender, sedation application, arterial puncture and venipuncture, Pearson Chi-Square Test was used when the presumptions of Pearson Chi-Square Test were met and Fisher's Exact Test was used when the presumptions were not met. In addition, Pearson Correlation Coefficient was used to investigate the relationship between block application time and height and weight. One-way and Two-way Analysis of Variance with Repeated Measures were used for intra-group and inter-group comparisons in terms of HR, SBP, MAP and DBP values at the measurement times. Descriptive statistics of continuous variables are presented as mean±standard deviation and categorical variables are presented as number of patients (N).

In this study, statistical analyses were performed using SPSS 16.0 statistical package program. The p values obtained in the test results were evaluated at α=0.05 significance level.

RESULTS

There was no significant difference between the groups in terms of sensory block onset time, motor block onset time, sensory block onset time, motor block onset time (Table 1).

There was no statistically significant difference between the groups in terms of demographic data, duration of anesthesia, tourniquet time and operation time (Table 2).

Table 2. Demographic data

	Group B (N=15)	Group L (N=15)	p
Age (years)	36±14.4	38.3±12.1	0.645
Height (cm)	172±9	167.7±10.3	0.232
Weight (kg)	82.4±13.1	75.2±11.2	0.117
Tourniquet duration (min)	62.9±27.5	64.2±22.1	0.887
Operation time (min)	76.4±30.4	81.4±30.3	0.655
Anesthesia duration (min)	115±40.6	112 ±32.2	0.82

Values are given as mean±standard deviation. p<0.05 was considered significant.

There was no statistically significant difference between the groups in terms of mean blood pressure and heart rate levels at any follow-up time (Figure 1).

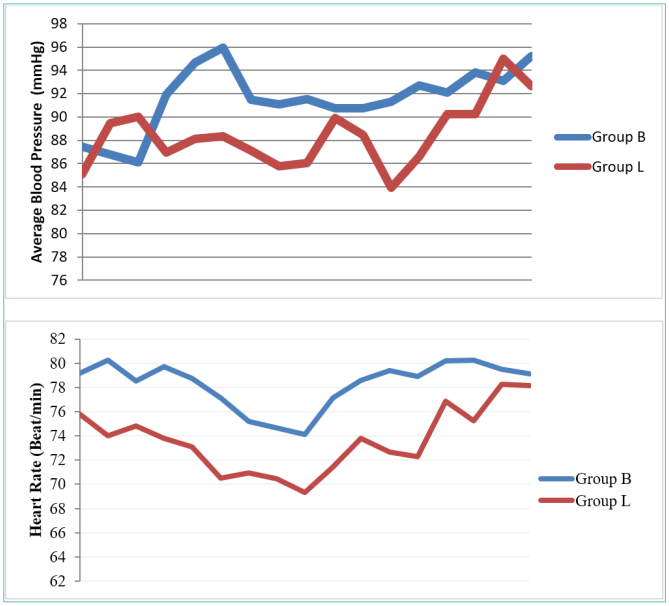

Figure 1. Mean blood pressure and heart rate levels

There was no significant difference between the groups in terms of duration of block administration, number of doses demanded, number of doses delivered, and total amount of anesthetic (Table 3).

Table 3. Block administration time, requested dose, administered dose, total anesthetic amount

	Group B (n=15)	Group L (n=15)	p
Block administration time (min)	5.33±1.54	5.07±0.88	0.566
Requested dose (n)	29.53±7.04	26.93±9.81	0.411
Administered dose (n)	16.07±5.75	12.60±4.67	0.081
Total anesthetic amount (ml)	199.33±31.33	183.00±23.36	0.117

Values are given as mean±standard deviation. p<0.05 was considered significant.

DISCUSSION

Due to the side effects of general anesthesia during induction, maintenance and awakening, regional anesthesia techniques are increasingly preferred for appropriate operations. Considering that a significant proportion of hand surgery procedures are emergency and all of patients, it is possible to avoid the side effects of general anesthesia with brachial plexus blockade in these patients. In the study performing by Hadzic et al.[6] general anesthesia and brachial plexus blockade were compared in outpatient hand surgery interventions, and it was revealed that the postoperative analgesia score was better with regional anesthesia, there was no need for additional analgesia, earlier ambulation was achieved and it was superior in terms of side effects.

Different doses and concentrations have been studied to find the ideal doses for axillary brachial plexus block. Cline et al.[7] reported that the onset times of sensory and motor blockade in the axillary brachial plexus block they performed with 40 ml 0.5% levobupivacaine were 19 and 27 minutes, respectively. In our study, this volume but low concentration of drug was used. The time to grade 2 sensory block was 16 minutes and the time to Grade 2 motor block was 14 minutes.

In patients where Cox et al.[8] used 0.25% levobupivacaine in supraclavicular brachial plexus block, the onset times of sensory and motor block were found to be 7 and 9 minutes, respectively. In our study, the onset time of sensory block was similar as 7 min in the 0.25% levobupivacaine group in which we used the same concentration but in higher volume. We think that this difference is due to another local anesthetic, lidocaine, which we added to the local anesthetics we used.

Transarterial, paresthesia and nerve stimulator techniques are used for axillary plexus blockade. The nerve stimulator technique provides exact needle localization without paresthesia. Success rates of all three techniques have been compared in various publications. Goldberg et al.[9] found the success rates after 40 mL of 1.5% mepivacaine injection to be 70%, 80% and 79%, respectively, in patients in whom they used the nerve stimulator, transarterial or paresthesia method with immobile technique (single injection), and found no statistically significant difference between them. Tuominen et al.[10] compared the success rates of paresthesia and nerve stimulator techniques using 0.5% bupivacaine. In the nerve stimulator group, adequate block level was achieved in all cases, whereas in the paresthesia technique group, 6.7% failure was encountered, but it was not statistically significant. In this study, we used the nerve stimulator technique similar to Tuominen et al.[10] and achieved adequate block level.

Although increasing concentration of local anesthetic solution does not increase the success rate of nerve block,[11] the total volume injected increases the chance of success and volumes >40 mL are recommended.[12] In our study, adequate surgical anesthesia was achieved with the nerve stimulator using the immobile technique without any neurological damage, using a low concentration and a total volume of 40 mL.

Sato et al.[13] investigated the efficacy of bupivacaine and levobupivacaine in equal doses in a study performed in 40 patients. A maximum dose of 40 ml of 0.5% bupivacaine and levobupivacaine was administered at 3 mg/kg or 0.6 ml/kg per patient, and 1/200,000 epinephrine was added to both local anesthetics. Casati et al.[14] performed sciatic nerve block using equal dose and volume of levobupivacaine and bupivacaine and found no significant difference in the quality and duration of motor block and sensory block. In our study, we administered 40 ml of 0.25% bupivacaine in 15 patients and 40 ml of 0.25% levobupivacaine in 15 patients. In our study in which we added lidocaine to two local anesthetic drugs, we found no statistically significant difference between the two groups in terms of the onset and duration of motor block.

In a study by Liisananttii et al.[15] in 90 patients undergoing hand and forearm surgery, 45 ml of 5% bupivacaine, levobupivacaine or ropivacaine was administered to each patient and the duration of sensory and motor block and the need for additional analgesics were noted. According to this study, complete motor blockade of the elbow was found to be 67% in the ropivacaine group, 30% in levobupivacaine and 47% in bupivacaine. Two patients in the levobupivacaine group and one patient in the ropivacaine group needed general anesthesia due to inadequate block. Local infiltration support was provided in 2 patients in the bupivacaine group, 6 in the levobupivacaine group and 4 in the ropivacaine group. In the same study, they also compared the times of first analgesic intake in the groups and found them similar. In this study, they used oral analgesics. In our study, there was no statistically significant difference between the two groups in terms of motor block onset times. No patient in either group required general anesthesia or additional nerve block. We think that this was due to lidocaine, another local anesthetic that we added to both groups.

Cox et al.[16] showed that the analgesic effects of levobupivacaine were mostly similar to bupivacaine at equal doses. Ozmen et al.[17] used levobupivacaine and bupivacaine infiltratively after tonsilectomy operation and found that their effects on postoperative analgesia were similar. In our study, we provided postoperative analgesia with patient-controlled analgesia with local anesthetic at a concentration of 0.125% through a catheter placed in the vascular-nerve bundle. We applied the patient-controlled analgesia PCA device at the end of surgery. We could not compare the first analgesic time, motor and sensory block termination times because we set the continuous dose of the PCA device as 5 ml/hour. We did not find a significant difference in local anesthetic consumption between the patients. In addition, in our study, we found that the postoperative analgesic effects of both local anesthetics at 0.125% concentration were similar in accordance with the literature.

Cox et al.[18] reported that a significant decrease in the incidence of systemic toxicity with local anesthetics from 0.2% to 0.01% has been observed in the last thirty years and that in peripheral nerve blocks, although the incidence of systemic toxicity was the highest at 7.5 per ten thousand, the rate of neural damage was the lowest at 1.9 per ten thousand. Urban et al.[19] compared the interscalene block they performed using the paresthesia method with the axillary block they performed using the puncture technique and observed that seizures occurred in only one case due to intravenous injection during the axillary approach. They also found mild paresthesia on postoperative day 1 in 19% and neuropraxia (transient conduction block) in 5% which disappeared within 2 weeks in the group in which axillary block was applied and reported that symptoms prolonged up to 4 weeks in 1 case. In our study, no side effects such as transient and permanent neurologic damage and seizures were observed in any of our patients and no intravenous injection was seen in any of our patients. In our study, we used a single injection method with a nerve stimulator and administered the drug by titrating and after frequent aspiration.

Although toxic symptoms associated with lidocaine usually occur when a plasma concentration of 10 µg/ml is reached, they can also be observed rarely at plasma concentrations between 6-10 µg/ml.[19] Palve[20] and Aantaa,[21] who used 900 mg of lidocaine with adrenaline in two separate studies of transarterial axillary block, achieved 100% success and reported that they did not encounter any problems in their patients who reached a plasma concentration of 5.6 µg/ml using a maximum of 18 mg/kg lidocaine. Although the maximum recommended dose of lidocaine has not been definitively established, it is known to vary according to the site of administration. For example, approximately 600 mg of lidocaine should be given to the plexus brachialis to achieve a plasma concentration of 5 µg/ml, while 300 mg of lidocaine used for intercostal block is sufficient to achieve this plasma concentration. The fact that no toxic reaction developed in the Palve[20] and Aantaa[21] studies despite the use of twice the maximum recommended dose may be related with the site of administration of the drug. It is known that venous absorption of drugs from the neurovascular sheath is slower and this is closely related with the therapeutic index of lidocaine.[22] In this study, we used 400 mg (mean 5 mg/kg) lidocaine in combination with other local anesthetics in both groups. It is known that there may be an additive interaction in local anesthetic combinations. Despite this, we did not encounter any side effects or complications with both drugs at the doses and concentrations we used. We believe that this is due to the slower venous absorption of drugs from the neurovascular sheath as mentioned above.

Unfortunately, this convenience with lidocaine cannot be said for bupivacaine. A dose twice the maximum dose cannot be recommended for bupivacaine. Cardiac side effects have been reported with the use of bupivacaine.[23] In addition, toxic plasma peak concentrations were reported to be reached in a patient in whom 3 mg/kg bupivacaine was used in axillary block.[22] We were able to limit the dose of bupivacaine to 1-2 mg/kg by using lidocaine, another local anesthetic. Therefore, no bupivacaine-related complications or side effects were observed in our study.

Limitations

The postoperative follow-up period for the patients in the study was 24 hours. The inability to monitor the long-term effects in the study participants was a limitation of our study.

CONCLUSION

We believe that both bupivacaine-lidocaine and levobupivacaine-lidocaine would be a very good combination and can be used safely without any difference in terms of block initiation and formation times and the total amount of local anesthetic consumed in postoperative analgesia.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Ethics Committee of Ankara Clinical Researches Ethics Committee No. 1 (Date: 11.01.2010, Decision No: 2010/01/198).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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