The effect of addition of lidocaine to bupivacaine on anesthesia beginning time, block time, and block quality in lateral sagittal infraclavicular block

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Aim: To investigate whether a 2% lidocaine addition to 0.5% bupivacaine that is used in a lateral sagittal infraclavicular block, when administered in an upper extremity surgery, decreases the block onset time, drug effect time, and drug activity when compared with bupivacaine alone.

Materials and methods: This study was performed on 120 American Society of Anesthesiology classification I–II patients who were 18–65 years old and scheduled to undergo an upper extremity surgery. The group testing in the study was as follows: 20 mL (5 mg/mL) bupivacaine, 10 mL (5 mg/mL) bupivacaine + 10 mL (20 mg/mL) lidocaine, and 20 mL (20 mg/mL) lidocaine were used respectively in the bupivacaine group, bupivacaine + lidocaine group, and lidocaine groups.

Results: The block onset time was very long in the bupivacaine group (P < 0.001). Motor block developed the fastest in the lidocaine group and the bupivacaine + lidocaine group (P < 0.001). Motor block regression was the fastest in the lidocaine group and the slowest in the bupivacaine + lidocaine group (P < 0.001). Loss of cold and touch sense was the fastest in the bupivacaine + lidocaine group and the lidocaine group (P < 0.001). Loss of sense of pain was the fastest in the bupivacaine + lidocaine group (P < 0.001). Postoperative analgesia requirement time was the longest in the bupivacaine + lidocaine group (P < 0.001). There were no differences among the satisfaction scores.

Conclusion: Lidocaine addition to bupivacaine significantly lowered the block onset time and extended the postoperative analgesia requirement time compared to bupivacaine alone and had no effect

Key words: Lidocaine, bupivacaine, upper extremity surgery, lateral sagittal infraclavicular block

1. Introduction
Brachial plexus block is a reliable regional anesthesia that is performed through various techniques for upper extremity surgery (1–3). The brachial plexus block with lateral sagittal infraclavicular (LSIB) method was defined for the first time by Klaastad in 2004 (4). They asserted that the LSIB method would be easy and safe, in a study performed on healthy adult volunteers using magnetic resonance imaging. The success rate of the LSIB technique implemented using neurostimulation (NS) varies between 89% and 91% (5).

Lidocaine is a local anesthetic that has medium solubility in water and lipids and a very wide usage area. It can be used in all regional block types with lower pKa. Although it is one of the agents that can also be used in peripheral nerve blocks, most clinicians prefer long-acting anesthetics for these blocks. The reason for this is the demand for a continued anesthetic effect in the postoperative period (6,7).

Bupivacaine, when compared with the other local anesthetics, is a long-acting and inexpensive anesthetic with a successful usage history. It maintains the specificity of the most widely used local anesthetics during the past few decades (8). Although bupivacaine is a long-acting anesthetic and forms a long-lasting block, it has the longest onset time. A bupivacaine + lidocaine combination in epidural anesthesia is used for both the longer and deeper block effect of bupivacaine and the fast onset time of lidocaine (9). The effect time of this combination is like the effect time of bupivacaine alone, or it tends to be shorter (10,11).

The primary purpose of this study was to determine whether a 2% lidocaine addition to 0.5% bupivacaine changed the onset time when compared with bupivacaine alone, which is used for LSIB when it is administered to patients before hand surgery; the secondary purpose was to determine whether the addition decreased the effect time and activity of bupivacaine.

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2. Materials and methods

This study was conducted at the Erzurum University School of Medicine Research Hospital between January 2009 and January 2010 with the approval of the Erzurum University School of Medicine Ethics Committee. The study was performed as a randomized and double-blind study, urgent or elective, on 120 American Society of Anesthesiology (ASA) classification I–II patients, between 18 and 65 years of age who had 50–100 kg body weight and required either forearm or hand surgery. All the patients who were involved in the study were informed about the study protocol and their written consent was obtained. The patients involved in the study were randomly divided into 3 equal groups of 40 each.

Group B: 20 mL (5 mg/mL) bupivacaine (Marcaine vial 0.5%, AstraZeneca, UK).

Group B + L: 10 mL (5 mg/mL) bupivacaine + 10 mL (20 mg/mL) lidocaine (Jetokain 2%, ADEKA, Turkey).

Group L: 20 mL (20 mg/mL) lidocaine (Jetokain 2%, ADEKA).

The LSIB technique according to Klaastad was administered in all 3 groups. The patients that were receiving hypotensive or antithrombolytic treatment, had a neurological disease or infection in the intervention area, were allergic to local anesthetic drugs, or were alcohol and/or narcotic addicts were excluded from the study.

The patients were introduced to the regional anesthesia application room within the operating room. Blood pressure (systolic and diastolic pressures), heart rate, and peripheral oxygen saturation (SpO_2) were monitored. All the values were measured and recorded before the operation. Peripheral vascular access was established using an intravenous cannula (20 G, Polycan IV cannula, India) in the dorsum of the hand that would not undergo a surgery. All the patients were sedated with 2 mg midazolam (Dormicum 5 mg, Roche, Switzerland) before the intervention.

The patients were laid in the supine position. The arm to which the block would be administered was positioned in adduction; the forearm was placed in 90° flexion, with the palm on the patient's abdomen. In electrocardiography, the electrode was adhered to the deltoid muscle of the arm to which the block would be administered. Stimupleks (HNS 12, B Braun Melsungen AG, Germany) was used as nerve stimulator, and special 22-G, 80-mm Stimupleks D needles (B Braun Melsungen AG) for plexus anesthesia were used. The medial side of the coracoideus was palpated on the lower side of the clavicle. The region to which the operation would be applied was disinfected with povidone-iodine (Batticon 10%, ADEKA) and local anesthesia was applied at the needle insertion site by cutaneous and subcutaneous injection of 1–2 mL of 2% lidocaine. The needle was inserted at the point of the coracoid process, on the lower front border of the clavicle through the skin, and on the sagittal plane. It was advanced slowly and caudally at 0–30° to the frontal plane, with an activation time of 0.1 ms, frequency of 2 Hz, and current of 1.5 mA for nerve stimulators. Contractions that were noticed at the bicep muscle were ignored; the needle was advanced until flexion in the first 3 fingers, flexion in wrist, or opposition in the thumb was observed (such as medial nerve movement). When radial nerve-like movement was observed, the needle was withdrawn and was redirected after the angle was reduced. These 3 movements were considered to be adequate for injection of the local anesthetic drug. When a response was not received, the needle was withdrawn up to the subcutaneous layer and redirected with a steeper angle. When flexion occurred in the first 3 fingers, flexion in the wrist, or opposition movement in the thumb was observed, the activating current was reduced gradually because the brachial plexus could have been approached. The needle was slowly and cautiously advanced until muscle contraction proceeded at 0.3 mA to indicate the optimum needle-tip–nerve relation. The needle was fixed and aspired at this point and when there was no bleeding observed, a local anesthetic solution was injected and the aspiration was repeated per 3–4 mL while the patient was monitored for local anesthetic toxicity. The block establishment time, needle insertion depth, needle insertion angle, and the number of needle redirections were recorded for all the patients.

After the process was completed, the region of the operation was evaluated, and assessments of sensorial block with cold-hot, pin-prick, and touch tests were recorded at 5, 10, 20, and 30 min for the sensorial regions of the median, ulnar, radial, musculocutaneous, axillary, median antebrachial, and median brachial cutaneous nerves. Assessments of the quality of the motor block using a Lovett rating scale for the sensorial regions of the median, ulnar, radial, and musculocutaneous nerves were also done. Recording of the sensorial and motor block assessments continued at 60, 120, 240, 480, and 720 min.

Motor block onset time was measured as the time between local anesthetic injection and the initial signs of reduction in muscular strength. Loss of motor block was evaluated with the Lovett rating scale (6 = normal muscular strength, 5 = slightly reduced strength, 4 = significantly reduced muscular strength, 3 = slightly impaired movement, 2 = significantly impaired movement, 1 = almost complete paralysis, 0 = complete paralysis). The pin-prick test (none = 0, present = 1), loss of sense of cold (hot = 0, cold = 1), and loss of tactile sense (none = 1, present = 0) were used in evaluating the sensory block.

Block onset time was determined as the time until pain sensation or cold sensation was lost in 1 of the 5 nerves respectively using the pin-prick test and the hot-cold test after local anesthetic injection, and the results were recorded.

Sensory block time was recorded from the beginning of the sensory block onset until the sense of pain began, and motor block time was recorded as the time between the onset of the motor block and the time at which the arm began to move again. The sensory block onset time of the patients and the time at which they first sensed pain were determined, and postoperative analgesia requirement times were calculated.

Successful block time is defined as adequate analgesia or anesthesia in all 5 nerves under the elbow. If there was anesthesia or analgesia in all 5 nerves under the elbow before 30 min or at 30 min, the surgery was started. If there was no anesthesia or analgesia in any of the nerve regions after 30 min, the block was considered inadequate and general anesthesia was applied. If there was no anesthesia or analgesia in any of the median, ulnar, radial, or musculocutaneous nerve regions at 30 min, a supplementary block was applied. In this application, radial, median, and ulnar nerve blocks at the elbow were performed. If there was anesthesia or analgesia in only 1 nerve region, it was considered an inadequate block and general anesthesia was applied. All the complications related to intervention, tourniquet time, number of patients, and operation times (hematoma, local anesthetic toxicity, pneumothorax, and neurapraxia) were recorded.

Pain complaints were evaluated in the postoperative period with a verbal rating scale (0 = no pain and 10 = the worst pain imaginable, pain intensity evaluated using a scale between 0 and 10) and a satisfaction score (0 = poor, 1 = moderate, 2 = good, 3 = very good, 4 = excellent), and patient satisfaction and pain levels were recorded.

We planned to use propofol if agitation and discomfort were observed in patients. If required, a 30 mg IV bolus or 1–2 mg/kg per hour of propofol (propofol 1%, Fresenius, Germany) infusion was administered.

2.1 Statistical analysis

The decrease of the block onset time of bupivacaine by 25% with the addition of lidocaine to bupivacaine was considered clinically significant. When the α error and β error were considered, respectively, as 0.05 and 0.10 with 90% power, the patient number for each group was determined as a minimum of 32. SPSS 15.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. A two-way analysis of variance (ANOVA) was used for demographic data, features of the block technique (needle insertion depth, block establishment time, needle insertion angle, and number of needle redirections), tourniquet time, block onset time, postoperative analgesia requirement time, number of patients applied, and surgery time. The chi-square test was used in the evaluation of the ASA patient satisfaction and intraoperative sedation. $P < 0.05$ was considered statistically significant.

3. Results

In 1 patient in group B, 2 patients in group L, and 2 patients in group L + B, the block was inadequate; thus, general anesthesia was applied and they were excluded from the study.

A supplementary block was not administered to any of the patients. We observed no complications (hematoma, local anesthetic toxicity, pneumothorax, or neurapraxia) related to the intervention. There were no statistically significant differences among group B, group L, and group B + L with respect to demographic data and features of the block technique ($P > 0.05$).

No statistically significant differences were determined among group B, group L and group B + L in terms of sex, age, ASA score, weight, height, depth of needle insertion, block establishment time, needle insertion angle, or number of needle redirections ($P > 0.05$, Table 1).

Block onset time was longer in group B than in the other groups ($P < 0.001$ for both).

Postoperative analgesia requirement time was longer in group B + L than other groups ($P < 0.001$ for both). Block onset time and postoperative analgesia requirement times are shown in Table 2.

Comparisons in terms of patient satisfaction were made among the B, L, and B + L groups. Patient satisfaction was evaluated with 5 different scores, between poor and excellent. Although 8 patients in group B + L and 3 patients in the other 2 groups reported patient satisfaction as very good, there was no statistically significant difference among groups. Intraoperative sedation was administered to only 2 patients in group B + L, to 5 patients in group B, and to 6 patients in group L. However, no statistically significant differences were noted.

No significant differences were determined among the groups with respect to patient satisfaction and intraoperative sedation ($P > 0.05$).

The block was successful in 95.8% of the patients. Successful block time was determined as: group L, 16.04 ± 6.9 min; group B + L, 12.05 ± 5 min; group B, 25.9 ± 4.9 min.

4. Discussion

Nowadays, if adequate analgesia and appropriate surgical conditions are provided for hand, wrist, forearm, and arm surgery, any surgery under regional anesthesia is considered a safer method than surgery under general anesthesia. Schulz-Stübner (12) argued that the brachial plexus block is an effective method and can be used securely for anesthesia or analgesia in hand and arm surgery. Hadzic et al. (13) compared general anesthesia and infraclavicular block in ambulatory hand surgeries in their study and found that general analgesia and infraclavicular block were better, that there was no need for additional analgesia, and that it was superior with respect to side effects.

Table 1. Demographic data and features of block technique.

	Group B (n = 39)	Group L (n = 38)	Group B + L (n = 38)	P-value
Sex (M/F)	30/9	26/12	27/11	0.345
ASA (I/II)	31/8	26/12	32/6	0.340
Age (year)	34 ± 15.7	40 ± 17.2	37 ± 6.9	0.337
Weight (kg)	69 ± 9.8	67 ± 8.7	69 ± 7.3	0.514
Height (cm)	170 ± 6.9	167 ± 8.7	169 ± 7.6	0.085
Depth of needle insertion (cm)	4.8 ± 0.73	4.6 ± 0.65	5.0 ± 0.48	0.085
Block establishment time (min)	5.3 ± 2.46	5.0 ± 1.55	5.3 ± 1.86	0.790
Needle insertion angle				
10°	0	1	0	
15°	17	14	8	0.345
20°	19	18	24	
25°	3	6	6	
Number of needle redirections				
1	3	2	3	
2	19	22	20	
3	11	9	13	
4	3	2	1	0.240
5	3	2	0	
6	0	0	1	
7	0	0	1	

There were no differences between the groups.

If there are no contraindications to regional anesthesia in these cases we prefer brachial plexus block. We have used the LSIB technique for brachial plexus block in patients undergoing forearm and hand surgery in clinical practice in recent years. This method was also used in this study. We examined block onset time and postoperative analgesia requirement times in 39 patients and found that lidocaine in addition to bupivacaine significantly decreased block onset time and increased drug effect time, but did not decrease the activity of drug. Average block onset time and postoperative analgesia requirement time were calculated, respectively, as 9.7 ± 1.86 min and 4.4 ± 1.21 h.

Hickey et al. (14) used 0.25% bupivacaine for brachial plexus block and determined that this concentration was inadequate due to high rates of failure. They recommended that bupivacaine be used in 0.5% concentrations in the anesthesia for brachial plexus block. Cox et al. (15) used bupivacaine in 0.5% concentration for brachial plexus block in the study that they conducted.

Both the 0.25% and 0.50% bupivacaine concentrations provided adequate anesthesia in our study. Pedro et al. (16) determined that sensorial block onset time was approximately 9 min in a supraclavicular brachial plexus block established with 30 mL of 0.5 % bupivacaine. The results found in that study are compatible with the results of our study. Liisanantti et al. (17) found postoperative first analgesia requirement time for bupivacaine as 17.8 ± 7.2 h. These results differed from our findings. The reason for this difference may be the higher drug volume used by the other researchers.

Classically, adequate anesthesia with lidocaine for surgery starts approximately at 15–30 min and continues for 2–3 h (18). In our study, block onset time was approximately 4.4 ± 1.03 min; postoperative analgesia requirement time was approximately 2.6 ± 0.62 h in the patients of group L. Movafegh et al. (19) determined sensorial block onset time and motor block onset time as 10 ± 3 min and 15 ± 5 min, respectively, in the axillary brachial plexus block established by using 34 mL of 1.5% lidocaine. Harper et al. (20) established an axillary brachial plexus block in 19 patients using lidocaine at 1.5% concentration with 1/200,000 adrenaline and determined that the minimum local anesthetic dose to establish an effective sensorial block was 3–3.5 mL. The measured sensorial block occurrence with lidocaine doses at these amounts was approximately 20 min, and the total sensorial block time was 2–2.5 h. O'Donnell et al. (21) established

Table 2. Block onset time and postoperative analgesia requirement times.

	Group B (n = 39)	Group L (n = 38)	Group B + L (n = 38)
Block onset time (min)	9.7 ± 1.86	4.4 ± 1.03*	4.0 ± 1.31*
Postoperative analgesia requirement time (h)	4.4 ± 1.21**	2.6 ± 0.62**	6.1 ± 2.21

Values are means ± SD. *: $P < 0.001$ compared with group B. **: $P < 0.001$ compared with group B + L.

an axillary brachial plexus block in 11 patients using 2% lidocaine (1–4 mL) with ultrasonography (USG). They determined that the total block times were between 3 and 4 h and block onset time was approximately 5 min. The difference between the times obtained for lidocaine in our study and the times in the literature can be attributed to difference in the amount of anesthetic used and the different techniques applied.

The usage of a combination of local anesthetics in regional anesthesia has been very popular in recent years (18). These kinds of combinations take advantage of the additive effect of both local anesthetics and the probability that toxicity decreases when compared with single usage of high doses of drugs (22). However, there are limited numbers of controlled studies that compare local anesthetics for the brachial plexus block (23).

In our study, the average block onset time and postoperative analgesia requirement time was calculated as 4.0 ± 1.31 min and 6.1 ± 2.21 h, respectively, in group B + L.

Salazar and Espinoza (24) administered a 40-mL 1/200,000 solution with epinephrine in combination with 2% lidocaine with 0.5% bupivacaine to the first group, 1% lidocaine with 0.25% bupivacaine to the second group, and 1.5% lidocaine with 0.37% bupivacaine to the third group. They determined that the postoperative analgesia requirement times were 11 h for the first group, 5.5 h for the second group, and 8.4 h for the third group. They reported that successful anesthesia was 95% for groups 1 and 3 and 75% for group 2. Gianesello et al. (25) used a mixture of 0.5% bupivacaine and 2% lidocaine in equal amounts in a study performed with 100 patients for axillary brachial plexus block. As a result of their study, they determined that the block onset time was 9.8 ± 2.3 min. Similarly, Sia et al. (26) determined that block onset time was 15 ± 6 min with a 40-mL local anesthetic mixture.

The success rate of the LSIB technique implemented by using neurostimulation varies between 81% and 91%.

Gürkan et al. (27) administered 40 mL of local anesthetic (with 5 µg/mL adrenaline) with a neurostimulator (NS)-guided LSIB technique according to radial, medial, or ulnar response in a series of 380 diseases. In this study, block onset time was 20 min and block success was 89.7%. Koscielniak-Nielsen et al. (28) investigated posterior cord response in a multicenter study and stated that block success was 91% and block onset time was 20 min with local anesthetic at a 0.5 mL/kg dose. They ascertained that the LSIB technique was safe in terms of axillary artery puncture, and posterior cord stimulation increased block success (98%). Block success was 88% in cases where median nerve response was sought. We determined that a 20-mL local anesthetic injection performed according to median nerve response from the median cord resulted in a high block success rate of 95.8%. Sensorial block onset time was 12.05 min in the group to which the bupivacaine + lidocaine mixture was administered. Sauter et al. (29) used 0.6 mL/kg mepivacaine (with 2 µg/mL epinephrine) in a study where they compared USG and NS methods for the LSIB technique; they stated that block success rates were 85% and 95% and sensorial block onset times were 13.7 and 13.9 min for NS and USG, respectively.

Our success rates are among the standards of all other studies in the literature. Furthermore, the characteristic that distinguishes our study from the others was that the local anesthetic volume was kept low and an adjuvant drug was not added. This success rate might have been associated with the intensive usage of neurostimulators and local anesthetic injection performed by getting a median nerve response from the median cord in our clinic

In conclusion, bupivacaine + lidocaine combination may be a good alternative to bupivacaine or lidocaine used alone because the combination decreases block onset time and it prolongs postoperative analgesia requirement time. The additional advantage of local anesthetic combinations is in higher patient satisfaction and comfort.

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