COMBİNED AXİLLARY BLOCK WİTH "SELECTİVE" İNJECTİON OF NERVES AND THE AXİLLARY CATHETER: COMPARİSON OF BUPİVACAİNE 0.25% OR LEVOBUPİVACAİNE 0.25%

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Abstract

Purpose: The aim of this study is to apply combination of axillary plexus block with "selective" injection of nerves and continuous catheter technique, and to compare the anesthetic and postoperative analgesic effects of bupivacaine and levobupivacaine.

Methods: In 30 scheduled patients for unilateral hand or forearm surgery, an axillary brachial plexus block with "selective" injection of nerves and continuous catheter technique was performed with 40ml of 2.5 mg/ml of bupivacaine, or levobupivacaine. After catheter placement, motor and sensory block were scored, and the patient was interviwed in the postoperative first 24 hours. The postoperative first analgesic need, total analgesic needs, pain scale and side-effects were registered.

Results: At the 30th min, complete sensory block was more frequent in the inervation area of the median nerve in the Bupivacaine group than Levobopivacaine group, and in the Bupivacaine group, complete sensory block was more frequent in the inervation area of the median nerve than the other nerves (P<0.05). Simultaneously, partial motor block of radial nevre was more frequent in the levobupivacaine group (P<0.05). Tourniquet was well tolerated in all patients with successful block in both groups. Mean duration of analgesia was similar to the bupivacaine and levobupivacaine groups at 14.2 h, and 18.4 h, respectively (NS).

Conclusion: In this tecnique, for median and radial nevre, bupivacained 0.25% produced slightly beter sensory and motor block intensity than levobupivacaine 0.25% in onset of the block. General success in relation to surgery and in the duration of the analgesia was identical in the two groups.

Keywords: Levobupivacaine, bupivacaine, axillary block, continuous catheter technique.

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Introduction

Axillary brachial plexus block (AXB) is the most effective for surgical procedures distal to the elbow[1]. There are anesthesiologists who find AXB suitable for elbow surgical procedures, and continuous axillary catheter techniques may be indicated for postoperative analgesia in these patients. Due to the fact that this block is carried out distant from both the neuraxial structures and lung, complications associated with those areas are avoided[2]. The multiple-nerve stimulation technique for axillary block, in which the 4 distal nerves of the plexus are identified by a nerve stimulator and separate injections for each performed, has obtained a high success rate and a rapid onset of block[3].

Continuous peripheral nerve block (CPNB) has been used for over half a century. However, despite efficacy, it has not become widely used[4]. While using a continuous catheter technique for postoperative analgesia, paying attention to securing the catheter will help prevent its unintentional removel. Continuous peripheral nerve blocks are useful in providing surgical anesthesia and postoperative analgesia with minimal side effects.

Bupivacaine HCl is a frequently used local anesthetic and it has the clinical advantages of long duration of action and favorable ratio of sensory to motor neural block. Bupivacaine has a chiral center and it is a racemic mixture of two stereo-enantiomers. Previous studies in animals, volunteers and patients have demonstrated a significant decrease in symptoms of cardiac or central nervous system (CNS) toxicity with the use of the single (S-)-enantiomer levobupivacaine as compared with equal doses of racemic bupivacaine[5,6].

However, it is suggested that insufficient studies have been carried out with levobupivacaine to date. Additionally, the effects of 0.25% bupivacaine have not been compared to 0.25% levobupivacaine specifically in continuous axillary block. Therefore, we compared the onset time, the anesthetic effects, the side effects, and the postoperative analgesic effects of bupivacaine and levobupivacaine in combined axillary brachial plexux block with "selective" injection of nerves and the axillary catheter.

Methods

This study was planned in the Anesthesiology and Reanimation Department of Medical Faculty, Gaziantep University (Turkey) between **October 2007 - March 2008**. The study was approved by the University Ethical Committee and a written informed consent was obtained from each patient. The work presented has been performed in accordance with the most recent version of the Helsinki Declaration.

The study included 30 American Society of Anesthesiologists (ASA) physical status I and II patients ranging from 18 to 60 years of age. All patients required emergency or elective unilateral hand or arm surgery. In all cases, adequate anesthesia could not be provided by the block of only one of the nerves that form the brachial plexus. The patients who were pregnant, morbidly obese, drug addicts, had chronic analgesic therapy, had neuralgic deficit on any part of his/her body, did not want to participate in the study, were mentally retarded, were allergic to amid group of local anesthetics, had coagulopathy, had infection on the region where block would be applied, were excluded from the study. On the day before surgery, patients received instructions on measure pain with a visual analog scale (VAS) that consisted of an unmarked 10-cm line, with 0 cm representing no pain and 10 cm representing the worst pain imaginable. And postoperative pain methodology during the 24 h period was explained to all patients.

Patients were randomly allocated to one of two groups: group 1, bupivacaine (Marcaine®, 5 mg/ml, Eczacıbaşı/Turkey, Astra Zeneca, England) (n=15) and group 2, levobupivacaine (Chirocaine®, 5mg/ml, Abbott Lab./Turkey, Nycomed Pharma AS, NO-2418, Elverum, Norvey) (n=15). Patients were taken to the regional anesthesia-application room located in the surgical department. Their blood pressures (systolic, diastolic and mean arterial blood pressures), heart rates (HR) and peripheral oxygen saturation (SpO2) were monitored. A peripheral vascular route was opened on the dorsal part of the hand which would not undergo operation, and serum physiologic solution (at a rate of 5-7ml/kg/h) was infused by means of an intravenous cannule (18 G). For the purpose of premedication, a standard intravenous midazolam of 0.02 mg/kg was administered to all of the patients.

The patients were laid down in supine position. The arm was placed to 90° abduction and the forearm was put to 90° flexion and external rotation, with the patient's back of the hand placed on the table and the forearm parallel to the long axis of the patient's body. An ECG electrode was taped on the deltoid muscle of the hand for which the block was to be applied. After the axillary region was disinfected with povidon, a sterile covering was applied. Multistimpleks® (Pajunk, Germany) was used as a nerve stimulator, and it was used in conjunction with Contipleks D Set® (B. Braun Melsungen AG, Japan) 21G, 100 mm needles, which are specifically designed for peripheral nerve blocks. The cathode pole of the nerve stimulator was attached to the conductive end of the needle, and the anode pole was attached to the ECG electrode taped to the deltoid muscle. The stimulator was initially turned to 1.0 mA, 2Hz, 01 mS parameters. 2cc lidocaine at 2% concentration was injected into the subcutaneous area just over the artery which was fixed by the middle fingers of the left arm. To determine the needle insertion site, the direction of the artery was plotted by fixing the axillary artery on the humerus with the index and middle fingers of the left arm. The needle insertion point was marked immediately over the artery-pulse. From the needle insertion point, the needle was inserted parallel to the artery, at an angle of approximately 30° to the skin. While inserting the needle, the entrance into axillary sheath was observed from the fascia click felt during passing through the fascia, paresthesia formation, reflux of blood and the oscillation of the needle in harmony with the artery-pulse.

The twitching actions of the muscles innervated by the nerves that form the brachial plexus (n. medianus, n. ulnaris, n. radialis, and n. musculocutaneous) were investigated individually. Continuation of twitch after a twitching response was obtained from one of the nerves and the current was reduced to 0.5 mA, and this was thought to be the indication of a successful localization. Upon continuation of the twitch at 0.4 mA, a local anesthetic of 20 ml was given by repeating aspiration (group 1: bupivacaine 0.25% 20 ml or group 2: levobupivacaine 0.25% 20 ml).

At this point, the needle was removed by fixing the teflon sheath of the catheter. The catheter was then forwarded through the teflon sheath. The teflon sheath was removed over the catheter, which was fixed at an average 6 cm by using a sliding method. The catheter was fixed with tape (perifix). A further local anesthetic of 20 ml was then given. Subsequently, a tourniquet was applied to distal to the injection site both to prevent the local anesthetic disseminating to the distal and to obtain the early-deviated musculocutaneous nerve.

After local anesthetic was applied, monitoring commenced of the sensory block and motor block at the operation site. Sensory block was tested with pin-prick test at four different predetermined skin sites, corresponding to the innervation of the musculocutaneous nerve (forearm), radial nerve (dorsal I—II intermetacarpal area), median nerve (palmar side of the tip of 3rd finger), and ulnar nerve (palmar side of the tip of the 5th finger) at 5, 10, 15, 20, 30, 45, 60, and 90 min after injection. If surgery started before 45 min, the last tests of sensation were performed with a sterile needle. The effect was graded as normal, analgesia (pin-prick was not felt as sharp, but touch was still felt), and anaesthesia (pin-prick and touch were not felt). Motor block of the arm was assessed by using a three grade scale (normal, reduced power, complete loss of power) of flexion of the elbow, extension of the elbow, and handgrip, also with the same time intervals as above. The onset time of sensory and motor block of each nerve were recorded. The operation was started when the block was settled.

If the block was not complete with regards to the site of surgery after 45 min, the surgeon infiltrated 1% lidocaine at the incision site. If the patients experienced pain or tourniquet pain, 0.05- 0.1mg of fentanyl was administered intravenously. Tourniquet pain was recorded.

Patients who experienced anxiety were given midazolam 1-2 mg i.v. bolus.

Visual analogue pain scores (VAS) and additional analgesic requirements were assessed at 2, 3, 5, 10, 18 and 24 hours after surgery by nurses blind to the study medication. Bupivacaine or levobupivacaine 10 mL of 1.25 mg ml^{-1} was performed via axillary catheter to patients suffering from postoperative pain higher than 3. The number of requests for analgesia were recorded.

The period of time until the first requirement of analgesics was defined as the analgesia period. Side

effects (nausea, vomiting, dizziness, hypotension, difficult respiration and seizure) and complications (hematoma, preseizure excitation, seizure, pneumothorax, respiratory arrest, cardiac dysrythmia, or arrest, and infection signs (regional heating, edema, redness, pain) were assessed by the ward nurses at intervals of two hours. The catheter was removed at 24th hours after operation.

Considering the fact that "selective" injection of nerves for axillary brachial plexus block is the routine technique in our clinic, 15 patients in each group was considered to be sufficient for a comparison of relevant clinical parameters. Therefore no power analysis was performed.

The data obtained from the study was analyzed by using the SPSS (Statistical Package for Social Sciences) program (v10.0 for Windows). Student t test was performed for the evaluation of the difference between groups according to continuous variablers, and the relationship between categorical analysis was tested by Chi-square analysis. Results were evaluated in 95% confidence interval and at $p<0.05$ significance level.

Results

Demographic characteristics of patients in both groups and type of surgery are shown in Table 1. Demographic data was similar for both groups.

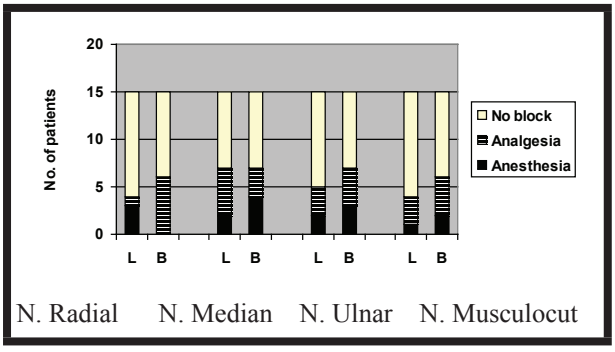
Ta-ble 1
Patient characteristics, types of surgery and intraoperative midazolam and fentanyl requirement

	Group B (n = 15)	Group L (n = 15)	P
Age (yr)	34.4 ± 10.9	29.6 ± 10.0	0,22
Gender (F/M)	1/14	3/12	0.70
Height (cm)	166 ± 8	171 ± 6	0.06
Weight (kg)	77.4± 9.2	79.4 ± 11.0	0,59
Typ of surgery (n)			
- hand	6	3	
- wrist	4	4	
- antebrachium	4	6	
- elbow	1	2	
Duration of surgery (min)	64,29 ± 43,4	56,20 ± 32,3	0,57

Data are given as mean ± SD or numbers of patients.

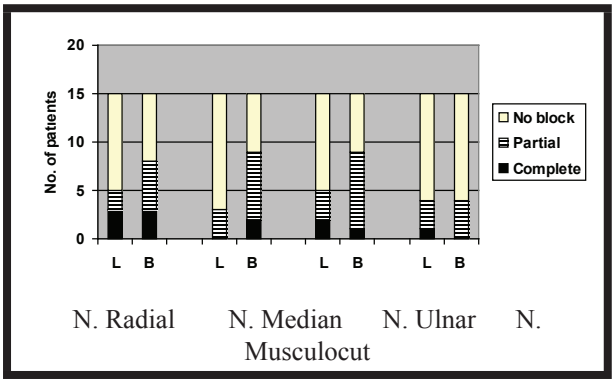
At the 5 min, partial sensory block of radial nevre and partial motor block of median nerve occured more often in the Bupivacaine group than Levobopivacaine group ($P < 0.016$, $P < 0.04$, respectively) (Fig. 1a, b).

Fig. 1a
Sensory block after 5 minutes



Number of patients receiving axillary brachial plexus block with bupivacaine-HCl (B), levobupivacaine-HCl (L), who developed anaesthesia (black), analgesia (striped) or no block (white), at the peripheral innervation areas of the radial, median, ulnar, and musculocutaneous nerve 5 min after injection. * $P < 0.05$; Partial sensory block was statistically significantly more frequent in the B group than in the L group.

Fig. 1b
Motor block after 5 minutes

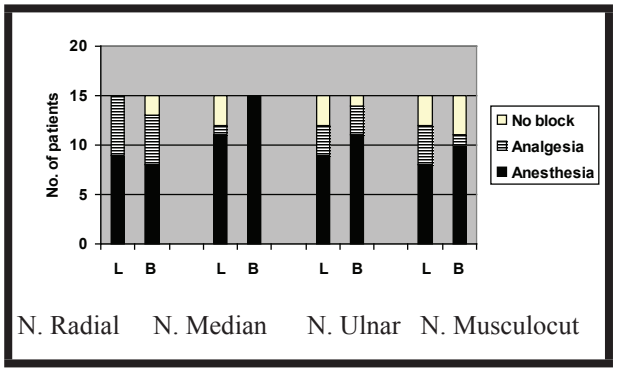


Number of patients receiving axillary brachial plexus block with bupivacaine-HCl (B), levobupivacaine-HCl (L), who developed complete loss of power (black), reduced power (striped) or no block (white) of the elbow movement and of hand clasp 5 min after injection. * $P < 0.05$; partial motor block occurred more frequently in the B group than in the L group.

There was no statistically significant difference in the quality of sensory block between the groups at 10th min (data not shown), 15th min (data not shown), 45th min (data not shown), 60th min and 90th min (data not shown) after injection. At the 5th min, analgesia (partial sensory block) was more frequent in the inervation area of the radial nerve in the Bupivacaine group than Levobopivacaine group ($P < 0.016$)

(Fig. 1a). At the 20th min, analgesia (partial sensory block) was more frequent in the inervation area of the radial nerve in the Levobopivacaine group than Bupivacaine group ($P < 0.019$) (data not show). At the 30 min, anaesthesia (complete sensory block) was more frequent in the inervation area of the median nerve in the Bupivacaine group than Levobopivacaine group ($P < 0.022$) (Fig. 2a). And in the bupivacaine group, anaesthesia (complete sensory block) was more frequent in the inervation area of the median nerve than other nerves at 30 min (P< 0.03) (Fig. 2a). Apart from these, anaesthesia was similar in the inervation areas of the main other nerves in the both groups at 5 min, 20 min, and 30 min.

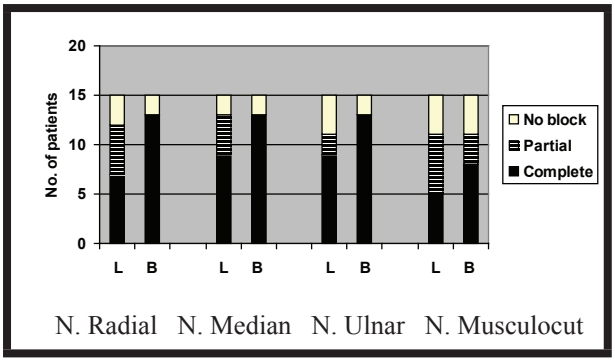
Fig. 2a
Sensory block after 30 minutes



Number of patients receiving axillary brachial plexus block with bupivacaine-HCl (B), levobupivacaine-HCl (L), who developed anaesthesia (black), analgesia (striped) or no block (white) at the peripheral innervation areas of the radial, median, ulnar, and musculocutaneous nerve 30 min after injection. * P < 0.05; Complete sensory block was statistically significantly more frequent in the B group than in the L group, and Complete sensory block of median nerve in the B group was statistically significantly more frequent than others.

The degree of block of the elbow movement and hand clasp at 10 (data not shown), 15 (data not shown), 20 (data not shown), 45 min (data not shown), 60 min and 90 min (data not shown) was similar in the two groups. At 5 min, partial motor block occurred more often in the Bupivacaine group than in the Levobupivacaine group (P=0.04) (Fig. 1b). At 30 min, partial motor block occurred more often in the Levobupivacaine group than in the Bupivacaine group (P=0.04) (Fig. 2b). Apart from these, complete or partial motor block of the elbow movement and hand clasp was similar in the other main nerves in the both groups at 5 min, and 30 min. There were no differences in the occurrence of complete motor block at 45 min between the two groups (data not shown). At 45 min, no patient was "no sensory block" and "no motor block" in the four inervation areas in both groups.

Fig. 2b
Motor block after 30 minutes

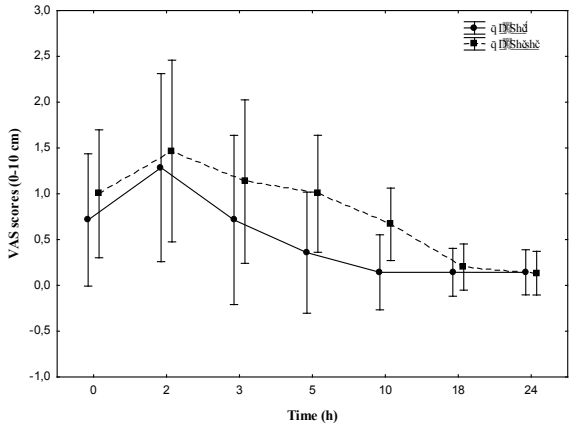


Number of patients receiving axillary brachial plexus block with bupivacaine-HCl (B), levobupivacaine-HCl (L), who developed complete loss of power (black), reduced power (striped) or no block (white) of the elbow movement and of hand clasp 30 min after injection. * P < 0.05; partial motor block occurred more frequently in the L group than in the B group.

A significant difference was not detected in either group at 0, 15, 30, 45 and 60 minutes in terms of mean arterial blood pressure (MAP) and heart rate (HR).

The intraoperative i.v. midazolam requirement was 1.71±1.06 mg and 1.73±1.27 mg for Bupivacaine group and Levobupivacaine group respectively. The intraoperative i.v. fentanyl requirement was 64.28±30.56 µg and 83.33±55.63 µg for Bupivacaine group and Levobupivacaine group respectively. No significant difference was found between groups in terms of intraoperative fentanyl and midazolam needs. Two different pain indicators were used: VAS and number of additional analgesic requests. As seen in Fig. 3, VAS values decreased within the first 24 h postoperatively in both groups ($P > 0.05$). Duration of analgesia was not markedly different for both groups (14.2 ± 11.0 hours and 18.4 ± 9.6 hours for Bupivacaine Group and Levobupivacaine Group respectively). The first need for postoperative additional analgesic arose in 6 patients in Bupivacaine Group and in 4 patients in Levobupivacaine Group (p=0,249).

Fig. 3
Mean visual analogue scores (VAS) for pain during the fist 24 h after surgery



Tourniquet was well tolerated in all patients with successful block in both groups. No serious complication was observed. There were no severely sedated patients in any group (no patient got in deep sleep), and no case of respiratory depression was observed. Immediate symptoms of intravascular injection and neurologic complications were not observed.

Discussion

The spread of LA around all nerves is obligatory to achieve complete AXB. Anatomical studies show the neurovascular space to be divided by multiple septae[7]. This is the main reason for incomplete AXB. Two different methods are used for solving the problem. One is the use of high LA volumes to achieve a good distribution in the axillary sheath[8]. This metod has a low risk of nerve damage, thus the cannula is not redirected in an area that has been already anaesthesised. However, incomplete blockades occur in patients with firm tissue surronding the nerves. The most effective second method is the multiple approach to terminal nerve branches by using nerve stimulation[3].

In 2001, Sia et al[3] compared a triple- nerve stimulation approach (musculocutaneous, median and radial) with quadruple-nerve stimulation approach in AXB. 81 patients were randomly allocated to either technique and a similar frequency of complete block (90–92%) was reported in that study[3]. In our study, we made a combination of two methods, which are the axillary brachial plexux block with "selective" injection of nerves and high LA volumes through the axillary catheter. In all patients, complete block was successful without any side effects. This study is the first study that has been used a combination of two methods in the literature.

The results showed some minor block intensity differences in favour of levobupivacaine 2.5 mg ml^{-1} in comparison with bupivacaine 2.5 mg ml^{-1} in axillary brachial blocks for hand surgery. However, from a general surgical anaesthesia point of view, the two local anaesthetics acted similarly. No significant differences were found between the groups regarding MAP, HR, intraoperative fentanyl-midazolam requirements and postoperative VAS scores. For median nevre and radial nevre, the first 30 min after AXB, complete sensory and motor block were more frequent in group B than in group L.

Biscoping et al[9] conducted a study of 15 patients undergoing plastic surgery of the upper extremity (elbow, forearm, and hand). They studied plasma levels and pain free intervals when performing catheter for the axillary plexus block with 0.5% and 0.25% bupivacaine as the postoperative analgesic agent respectively[9]. They found that the pain free interval after 30 ml of 0.25% bupivacaine lasted for an average of 10.5 hours. Liisanantti et al[10] raported that mean duration of the blocks was similar in the 45 ml of %0.5 bupivacaine, %0.5 levobupivacaine and %0.5 ropivacaine groups at 19.3 h, 19.5 h, and 17.3 h, respectively (NS). Although a lower concentration and volume of bupivacaine and levobupivacaine in the present study, the duration of postoperative analgesia (mean 14.2 h and 18.4 h) was similar in Liisanantti's study.

Cox et al[11] have compared the clinical effects of bupivacaine and levobupivacaine on the supraclavicular brachial plexus block. 0.25% levobupivacaine, 0.5% levobupivacaine and 0.5% bupivacaine were administered to 75 patients who had undergone elective hand surgery. In the study of Cox et al. no significant difference could be found between the two groups in terms of motor and sensory block. At the same time, Cox et al. have demonstrated that, at equal doses, the analgesic effects of levobupivacaine were highly similar to those of bupivacaine[11]. Similarly, we

determined in our study that equal doses (40) ml and concentrations (0.25%) of both local anesthetics had similar postoperative analgesic effects.

In the Cox et al.'s study, 3 patients in the bupivacaine group developed central nervous system (CNS) toxicity despite negative aspiration. This was found to be related to sinus tachycardia and hypertension but hypoxia did not develop[12]. In our study, we used 0.25% levobupivacaine and 0.25% bupivacaine. We could not find a significant difference between the two groups in terms of blood pressure and heart rate. None of our patients developed CNS and cardiac toxicity.

Liisanantti et al[10] reported a study carried out with 90 patients who underwent hand and forearm surgery. Each patient was administered 45 ml 0.5% bupivacaine, levobupivacaine or ropivacaine. According to this study, complete elbow motor block was found in 67% of the ropivacaine group, in 30% of the levobupivacaine group and 47% of the bupivacaine group[10]. That was explained with the high dose of three local anesthetics and patient's subjective evaluation and sensation which varies from case to case. Camorcia et al[13] determined

the minimum local analgesic doses of the three local anesthetics for intrathecal analgesia in the first stage of labor. The results showed that ropivacaine was 35% less potent than bupivacaine and it was 19% less potent than levobupivacaine in producing motor block[13]. Faccenda et al[14] investigated the clinical efficacy and safety of levobupivacaine compared with racemic bupivacaine for extradural anesthesia. They found that lower-limb motor block was significantly longer in the levobupivacaine group[14]. In the present study, for median nerve and radial nerve, we found that the onset of sensory and motor block were more frequent in group B than in group L. This result may be related firstly to patient's subjective evaluation and sensation which varies from case to case, secondly to the combination of axillary brachial plexux block with "selective" injection of nerves and the axillary catheter.

Despite exercising appropriate care, there is a risk of local or general infection. Johnson et al[15] reported that different local anesthetics showed various degrees of antimicrobial capacity. Bupivacaine and lidocaine, for example, inhibit growth to a significantly greater extent than does ropivacaine[15]. In the present study, no infection was seen in the patients after block. This may be the result of placing the catheter for only 24 hours, using the local anesthetics with 0.25% concentration and local anesthetic's anti-bacterial effects.

Tourniquet pain is a common problem complicating the use of a pneumatic tourniquet during surgical procedures including upper and lower extremities[16,17]. In our study, tourniquet was well tolerated in all patients with successful block.

In addition, despite the aspiration, low dose and concentration of local anesthesia and unintentional intravascular injection may occur, and the needle could lead to a hematoma and theoretically a neural injury. Especially, new users should be careful during the peripheral block[18]. Cox et al[12] reported that a marked reduction from 0.2% to 0.01% was observed in the incidence of systemic toxicity of local anesthesia within the last 30 years, and despite the incidence of systemic toxicity being at the highest level (0.075%) in peripheral nerve blocks, the neural damage rate was at the lowest level (0.019%). One randomised controlled study, which allocated 30 patients to (non-stimulating) infraclavicular and axillary catheters, reported similar success rates, performance times and block durations. However, the axillary catheters resulted in more vascular puncture (30 vs %: $P<0.05$)[19]. In our study, vascular puncture did not occur, this may be the result of the combined technique used for the brachial plexux block.

Tuominen et al. reported that they did not encounter any side effects despite higher doses used in orthopedic surgery patients to whom axillar block was applied[20]. In our study, no cardiovascular system and central nervous system complication was seen in both groups.

Further studies including a greater number of patients could be needed in order to investigate the effect of similar doses of levobupivacaine and bupivacaine in combination axillary brachial plexux block with "selective" injection of nerves and the axillary catheter.

In conclusion, for median and radial nevre, bupivacaine 0.25% produced onset of sensory and motor block and that was slightly better the than the same dose and the same concentration of levobupivacaine.

It is possible to form combination of axillary brachial plexux block with "selective" injection of nerves and the axillary catheter by using levobupivacaine 0.25% and bupivacaine 0.25% to perform intraoperative and postoperative pain control effectively without significant side effects or complications.

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