Comparison of Local Anesthetic Mixtures with Tramadol or Fentanyl for Axillary Plexus Block in Orthopaedic Upper Extremity Surgery

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ABSTRACT

The local anesthetic mixtures are performed for peripheral nerve blocks to accelerate the onset time of sensorial and motor blocks. Also adjuvant agents can be added to local anesthetics to improve the quality and duration of plexus blocks. In this study, we compared the effect of tramadol and fentanyl as adjuvant agents to local anesthetic mixtures in axillary plexus block for orthopedic upper extremity surgery. After approval of hospital ethics committee and written patient consent, sixty patients were enrolled to the study in three groups; The Control Group (Group C, 40 mL of 0.25% levobupivacaine + 40 mg lidocaine n:20), the Fentanyl Group(Group F, 40 mL of 0.25% levobupivacaine + 40 mg lidocaine + 50 mcg fentanyl n:20), the Tramadol Group (Group T, 40 mL of 0.25% levobupivacaine + 40 mg lidocaine + 100 mg tramadol n:20) for axillary plexus block. Groups were compared for partial and complete motor and sensorial block, onset time, partial and complete motor and sensorial block recover time, and postoperative first analgesic requirement time (VAS >4). In Group T partial sensorial block onset time was shorter than Group C and complete sensorial block onset time was shorter than Group C and Group F. In Group T complete sensorial block recover time was longer than Group C and Group F. The postoperative first analgesic requirement time was significantly longer in Group T and F when compared with Group C and significantly longer in Group T when compared with Group F. We conclude that the addition of tramadol or fentanyl to local anesthetic mixtures as an adjuvant agent for axillary block provide better postoperative analgesia for orthopedic upper extremity surgery. Furthermore tramadol more improves the block quality than fentanyl.

Key words: *Axillary block, local anesthetics, tramadol, fentanyl*

Ortopedik Üst Ekstremite Cerrahisinde Aksiller Pleksus Blok için Fentanil veya Tramadol Lokal Anestetik Karışımlarının Karşılaştırılması

ÖZET

Periferik sinir bloklarında duyusal ve motor bloğun hızlı başlaması için lokal anestezikler birlikte kullanılabilirler. Pleksus bloklarının kalite ve süresini artırmak için lokal anesteziklere adjuvan ajanlar da eklenebilir. Bu çalışmada tramadol ve fentanilin ortopedik üst ekstremite cerrahisi için aksiller pleksus blokta lokal anestezik karışımlara adjuvan ajanlar olarak eklenmesinin etkilerini karşılaştırdık. Hastane etik kurul onayı alındıktan ve hastanın yazılı onamından sonra 60 hasta çalışmaya dahil edildi. Hastalar 3 gruba ayrıldı. Kontrol Grubu (Grup C, 40 mL %0,25 levobupivakain + 40 mg lidokain n:20), Fentanil Grubu (Grup F, 40 mL %0,25 levobupivakain + 40 mg lidokain + 50 mcg fentanil n:20), Tramadol Grubu (Grup T, 40 mL %0,25 levobupivakain + 40 mg lidokaine + 100 mg tramadol n:20). Gruplar parsiyel ve tam motor ve duyusal blok, başlama, iyileşme süreleri ve postoperatif ilk aneljezik gereksinim süreleri açısından karşılaştırıldı (VAS >4). Grup T'de parsiyel duyusal blok başlama süresi Grup C'den kısa bulundu. Tam duyusal blok başlama süresi Grup C ve Grup F'den kısadır. Grup T'de tam duyusal blok iyileşme süresi Grup C ve Grup F'den uzundu. Postoperatif ilk aneljezik gereksinim süresi Grup C ile karşılaştırıldığında Grup T ve F'de anlamlı derecede uzundu ve Grup F ile karşılaştırıldığında Grup T'de anlamlı derecede uzundu. Lokal anestezik karışımlara adjuvan ajan olarak tramadol ya da fentanil eklenmesinin ortopedik üst ekstremite cerrahisi için daha iyi bir postoperatif analjezi sağladığı sonucuna vardık. Ayrıca, tramadolun blok kalitesini fentanilden daha fazla geliştirdiğini gözlemledik.

Key words: *Aksiller blok, lokal anestetik, tramadol, fentanil*

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INTRODUCTION

The axillary approach to the brachial plexus is a com¬monly used and efficient analgesia technique for hand wrist and/or forearm surgery (1,2). Local anesthetics, are often used in axillary block application. Considerable research has been conducted in order to determine the ideal drug or combination. An ideal drug would have a fast sensory onset time and a differential offset, with an earlier offset of motor rather than sensory blockade, thus enabling patients to move their arms while enjoying con¬tinued analgesia. Combinations of local anesthetics are employed for peripheral nerve blocks to accelerate the onset time of sensorial and motor blocks (3).

In addition, adjuvant agents are used to improve the quality and duration of nerve blocks and to reduce the need for supplementary analgesics for postoperative pain. There have been several studies concerning opioids, and particularly the use of fentanyl as an adjuvant agent. Fentanyl has been added to local anesthetics, with differ¬ent results, increase the success rate of sensory blockade and prolong the duration of analgesia in contrast did not find any effects on the time to onset of nerve block or time to first request for postoperative pain medication. being obtained (4-6). Tramadol, a synthetic codeine ana¬logue, has been used as an adjuvant to improve periph¬eral block quality in peripheral nerve block and to extend postoperative analgesia (7,8).

In this study, we compared the effect of sensorial onset, recovery and postoperative first analgesic requirement time of tramadol and fentanyl as adjuvant agents to local anaesthetic mixtures (lidocaine and levobupivacaine) in axillary plexus block for orthopedic elective hand, wrist and forearm surgery.

MATERIALS AND METHODS

This prospective, randomized, double-blind study de¬signed following institutional review board approval, written informed consent was obtained from patients undergoing elective surgery of the hand, wrist, or fore¬arm under axillary block using the nerve stimulation technique. Sixty American Society of Anesthesiologists (ASA) physical status I or II patients of aged between 18 and 60 were randomly allocated to one of three groups using sealed envelopes for this prospective, random¬ized, double-blind study.

Our exclusion criteria were; central or peripheral neuropathies; pregnancy; a history of allergic reaction to any of the study drugs; cardiac, respiratory, hepatic and/or renal failure; regional anesthesia being con¬traindicated; coagulation defects and infection at the puncture site were not included.

Patients were randomly allocated into one of three groups: the control group (Group C, 40 mL of 0.25% le¬vobupivacaine+2 mL (40 mg) lidocaine+2 mL saline, n:20), the fentanyl group (Group F, 40 mL of 0.25% levobupivacaine+2 mL (40 mg) lidocaine+2 mL (50 mcg) fentanyl, n:20), or the tramadol group (Group T, 40 mL of 0.25% levobupivacaine+2 mL (40 mg) lidocaine+2 mL (100 mg) tramadol, n:20) for axillary plexus block. Patients were not pre-medicated prior to the block. Details of the anesthetic technique, the study protocol and visual analogue scales were fully explained during the preoperative visits, and written consent was obtained from each patient before enrol¬ment in the study. After the insertion of an intravenous catheter and neurological examination, patients were monitored using electrocardiography, pulse oximetry, heart rate and non-invasive blood pressure measure¬ments (Datex-Ohmeda Cardiocap 5). The same axillary block was employed in all patients. The arm to be oper¬ated on was abducted to at least 90°, with the forearm in 90° flexion. The injection site was then subcutane¬ously infiltrated with 1 mL of 2% lidocaine. A 22-gauge, 40-mm, short bevelled, insulated, unipolar cannula (Pajunk, Geisingen, Germany) was connected to a nerve stimulator (Stimuplex HNS11TM, B. Braun, Melsungen, Germany) and inserted immediately above the artery until the brachial plexus was located. Block was then applied with only local anesthetic, fentanyl or tramadol according to the study groups. The anesthetist perform¬ing the block was aware of the site of surgery, although other staff members unaware of the patient's group sta¬tus evaluated the sensory and motor block. Sensory block was graded according to the following scale (9): 0:No block (normal sensation), 1:Partial block (decreased sensation) 2:Complete block (no sensation).

Duration of sensory block, defined as a return of sensa¬tion to pinprick in all nerve distributions, was also measured. Motor block was graded according to the following scale: 0: No block (full muscle activity), 1: Partial block (decreased muscle activity), 2: Complete block (no muscle activity)

Table 1. *Demographic data of patients in the three groups (mean ± SD)*

	Group C	Group T	Group F
Age (yrs)	45±9,96	42±14.8	38±15.5
Weight (kg)	69±10.8	74±14.9	65±15.4
Height (cm)	165±7.1	167±7.2	160±13.9
Male/Female	14/6	12/8	12/8

Table 3. *Adverse effects observed throughout the study*

	Group C	Group T	Group F
Nausea/Vomiting	0	2/0	1/0
Pruritus	0	0	0
Tinnitus	0	0	0

Time to onset of motor block (time to onset of Grade 1 motor block in any nerve distribution) duration of motor block (time from onset to a motor block score of 0 for all activities), and the proportion of patients reaching each grade of motor block were measured. If the block was not complete, the surgeon infiltrated 1% lidocaine at the incision site. If the patients experienced pain, 0.5-1 mcg/kg of fentanyl was administered intravenously.

Patients who experienced anxiety were given midazolam 1-2 mg i.v. or a propofol i.v. infusion. Those patients who had already requested sedation for the time of surgery were administered a continuous i.v. infusion of propofol. If, in spite of an additional infiltration of lido¬caine and i.v. fentanyl, the patient experienced pain, a general anaesthetic with propophol was to be adminis¬tered and a laryngeal mask airway (LMA) employed. At the end of surgery the patients were told to note the time at which, in their opinion, the arm was fully recov¬ered from the block. Blood pressure, heart rate (HR), peripheral oxygen saturation (SpO_2) were measured at the same time points. Additional adverse effects (i.e. nausea and vomiting, pruritus) were also recorded throughout the study period. Patients' conditions were checked by phone visits, or personally if the patient was still in hospital, at 8—11 a.m. by one of the investigators, blinded to which local anesthetic had been used. The next morning, all patients were interviewed again by telephone. The time to the first requirement for an analgesic (non-steroidal anti-inflammatory drug or paracetamol) was also recorded, as well as the time to the first analgesic. In addition, patient and surgeon were asked about their own personal degrees of satisfaction with the quality of the brachial plexus block for producing anesthesia and postoperative analgesia, and this was rated on a 2-point scale, 'satisfied' or 'dissatisfied'.

Statistical analyses

The Kolmogorov–Smirnov test was used for normality and homogeneity of data distribution. Parametric data(age, weight, height, onset and complete of sensory and motor blocks, postoperative first analgesic requirement times) were compared with one-way ANOVA. Post hoc comparisons were performed with Dunnett two-tailed t-test by using control as the reference control group. Discrete variables (sex, side effects) were compared by

Table 2. *Block characteristics and quality of analgesia*

	Group C	Group T	Group F	p value
Time to onset				
Partial sensory block (mins)	9±4.45	5±3.94*	7±3.73	<0.001
Complete sensory block (mins)	18±6.14	11±5.47[±]	15±5.08	<0.001
Time to onset				
Partial motor block (mins)	11±3.73	9±6.6	10±6.68	ns
Complete motor block (mins)	18±3.37	18±7.42	14±8.2	ns
Time to recover				
Complete sensory block(hours)	4±1.32	11±5.67[#]	8±2.83	<0.001,< 0.05
Complete motor block (hours)	4±1.14	10±5.32	7±2.57	ns
Postoperative first analgesic requirement time (hours)	5±1.40	19±6.34[§]	9±1.88[€]	<0.001

*Significance between Group T and Group C, [±]Significance between Group T and Group C,F, [#]Significance between Group T and Group C,F, [§]Significance between Group T and Group C,F, [€]Significance between Group F, and Group C, ns:non-significant

using ki-square-test. All data are presented as means (SD) or number. A p value <0.05 was considered as sta¬tistically significant. Calculation of number of patients is based on postoperative first analgesic requirement time. Power of study was used for power –Analysis pro¬gramme The power of study was 99% alfa:0.05.

RESULTS

There was no difference between the groups in terms of age, weight, height and sex. (Table 1). Surgical procedures were similarly distributed among the three groups. Block characteristics are shown in Table 2.

Onset of sensorial block

Partial sensorial block onset time

Partial sensorial block onset time in Group T was shorter than in Group C (p:0.01).

Complete sensorial block

Complete sensorial block onset time in Group T was shorter than in Group C and F (p=0.0006, p=0.03, respectively).

Onset of motor block

There was no significant difference between the groups in terms of onset of partial and complete motor block, recovery of sensation, return of full motor block.

Postoperative first analgesic requirement time

The postoperative first analgesic requirement time was significantly longer in Group T and F compared with Group C (p=0.0001, p:0.0001, respectively), and significantly longer in Group T compared with Group F (p=0.0001). In no case was propofol administration or general anesthesia required to complete surgery. Only two patients complained of pain (one patient in group C). The surgeon infiltrated 1% lidocaine at the incision site, iv fentanyl 1mcg/kg were given in this patients. Nausea was observed in two patients in group T and in one in group F (Table 3). These side effects were mainly of gastrointestinal origin. They were also transient and of short duration (maximum duration was 15 min in one patient in group F), and did not require any therapeutic intervention. Heart rate, non-invasive blood pressure, peripheral oxygen saturation exhibited no significant inter-group differences. No patients showed any signs of local anesthetic toxicity, inflammation of the puncture site or nerve lesion. No episodes of hypotension, bradycardia or hypoxemia as defined previously were observed in any group throughout the study. Patient acceptance was good in all the patients studied, and no complications were observed at postoperative follow-up. The telephone follow-up interview conducted after discharge revealed neither persistent nor recurrent side effects, and no post-block neurological complications were observed among the three groups. One of the patients in control group was dissatisfied. In all cases, surgeon satisfaction was obtained and two patients were dissatisfied.

DISCUSSION

This study showed that the addition of tramadol or fen¬tanyl to local anesthetic mixtures as an adjuvant agent for axillary block provide better postoperative analgesia for orthopaedic upper extremity surgery. Furthermore tramadol more improves the block quality than fentanyl.

Due to their long term impact, local anesthet¬ics are frequently used in axillary blockade (9,10). Levobupivacaine, an analogue of S-(-) bupivacaine, is used as alternative local anesthetic in peripheral blockade due to its reduced toxic effects. The toxicity of levobupivacaine to the cardiovascular and central nervous system has been reported to be less than bupivacaine (11,12). Therefore le¬vobupivacaine was preferred to use as the major local anesthetic in our study. Low dose lidocaine was used for the purpose of to accelerate sensorial onset time. In order to improve patient comfort, and particularly to maintain and prolong postoperative analgesia adjuvant agents (tramadol and fentanyl) were added to local an¬esthetics. Several studies have indicated that fentanyl and tramadol, a synthetic codeine analogue, increase the quality of peripheral blockade and improved the du¬ration of postoperative analgesia (6,7).

Opioids are frequently used in regional anesthesia as an adjuvant agent. The introduction discovery of opi¬oid receptors in the peripheral nervous system has led to research into opioid use as an adjuvant in pe¬ripheral blockade applications such as brachial plexus blockade. Gobeaux et al. added 100 mcg of fentanyl to adrenalinized lidocaine for brachial plexus block and re¬ported that when fentanyl was added this enhance-

ment of intensity and duration of sensory and motor nerve blocks allowed a reduction in the amount of lidocaine required and shortened the delay between injection and complete blockade (6). They suggested that this result might be related to the peripheral effects of opioids. The lipid solubility of fentanyl is thought to have had a perineural effect. Our study also supports the idea that the addition of fentanyl to local anesthetic com¬binations improves postoperative analgesia quality. The postoperative first analgesic requirement time was sig¬nificantly longer in Group T and F compared with Group C. In another study, Nishikawa et al. evaluated the ef¬fects of 100 mcg of fentanyl added to lidocaine for axil¬lary brachial plexus block and achieved an improved and prolonged sensory blockade (13).

In contrast, Morros Viñoles et al. concluded that the ad¬dition of fentanyl 100 mcg to mepivacaine in the axil-lary blockade of the brachial plexus did not alter the anesthetic characteristics nor the time of postoperative analgesia (5). Fletcher et al. were similarly unable to demonstrate any clinical benefits resulting from the ad-dition of fentanyl to local anesthetic for axillary bra¬chial plexus block (14). Fanelli et al. added fentanyl 1 mcg/mL to ropivacaine 7.5 mg/mL and determined that this did not improve the nerve block characteristics of axillary brachial plexus anesthesia for orthopedic proce¬dures involving the hand (15).

We similarly observed that the addition of fentanyl did not affect block characteristics but did extend initial analgesia requirement time. Different results can be ob¬tained with the effect of perineural fentanyl on postop¬erative initial analgesia requirement duration. Fentanyl was used in this study 50 mcg because we want to ex¬amine the effect of opioids in minimal dosages. The goal of this study was to observe the addition of adjuvant to local anesthetic mixtures, not that of adjuvant to a single local anesthetic.

Tramadol exhibits both opioid and non-opioid activities. Recent clinical and laboratory studies have concluded that tramadol displays a peripheral local anesthetic ef¬fect (17,18). Tramadol has been used as an adjunct to peripheral plexus anesthesia in recent publications. The results of our study showed that the addition of 100 mg of tramadol to local anesthetic mixtures for axillary brachial plexus block improves the speed of block onset and increases the duration of sensory block.

Kapral et al. demonstrated that the addition of 100 mg of tramadol to mepivacaine 10 mg/mL for axillary brachial plexus block resulted in a significant increase in the duration of the block, whereas intravenous tramadol (100 mg) exhibited no effect. Consequently, the results of that study suggest that tramadol has a specific analgesic effect on peripheral nerves (7). In a study in which it was added to 20 mL of ropivacaine 7.5 mg/mL, conducted by Antonucci, tramadol was shown to signifi¬cantly reduce the onset time of brachial plexus block and to prolong the duration of anesthesia and post-op¬erative analgesia (18). In our study, and similarly to that of Antonucci, we added 100 mg of tramadol to levobu¬pivacaine and lidocaine and observed a longer analgesia duration.

Kaabachi et al. investigated the addition of vary¬ing doses of tramadol to lidocaine 1.5% (epinephrine 1/200.000) solution and reported that the benefit of block prolongation associated with the addition of 200 mg of tramadol to lidocaine during axillary block was limited by the slow onset of the block (19). In our study, we found that the addition of 100 mg of tramadol to a local anesthetic mixture significantly shortened com¬plete sensorial block onset duration compared with both the fentanyl and control groups and that it maintained prolonged postoperative analgesia. Similarly, Robaux et al. added different doses of tramadol to mepivacaine 15 mg/mL for axillary brachial plexus block and reported that tramadol extended the duration and improved the quality of post-operative analgesia in a dose-dependent fashion (8).

In contrast, Kesimci et al. reported that the addition of 100 mg of tramadol to 7.5 mg/mL of ropivacaine, for axillary brachial plexus block, does not prolong the duration of motor and sensory block and analgesia (20). The reason may be addition to single local analgesic. In our study we added tramadol to levobupivacaine and lidocaine mixture. Similary, Sarsu et al. performed axil¬lary blockade by adding 100 mg of tramadol to combi-nation levobupivacaine and lidocainee. They reported that tramadol was not effective on sensorial and mo-tor block durations, onset time, and analgesia duration (21). The reason for this may be the higher dosage of lidocaine (200 mg) than we've used in our study (40 mg) . It seems that there are many factors affecting the char¬acteristics of block in axillary application. Different results related to adjuvant agents appear in the litera¬ture. This may be due to the use of local anesthetics, experience of the practitioner etc.

In conclusion, the addition of tramadol or fentanyl to local anesthetic mixtures as an adjuvant agent for axillary block provide better postoperative analgesia for orthopedic upper extremity surgery. On the other hand tramadol addition is seemed superior than fentanyl ad¬dition. Of course, in order to support this statement fur¬ther studies must perform related this topic.

REFERENCES

1. *Brockway MS, Wildsmith JAW. Axillary brachial plexus block: method of choice? Br J Anaesth 1990; 64: 224-31.*
2. *Janzen PR, Vipond AJ, Hopkins PM, et al. A comparison of 1% prilocaine with 0.5% ropivacaine for outpatient-based surgery under axillary brachial plexus block. Anesth Analg 2001;93:187-91.*
3. *M. Freitag, K. Zbieranek, A. Gottschalk, M. Bubenheim, R. Winter, S. Tuszynski, T. G. Standl Comparative study of different concentrations of prilocaine and ropivacaine for intraoperative axillary brachial plexus block. Eur J Anaesth 2006;23:481-6.*
4. *Karakaya D, Büyükgöz F, Bariş S, et al. Addition of phen¬tanyl to bupivacaine prolongs anaesthesia and analgesia in axillary brachial plexus block. Reg Anesth Pain Med 2001;26:434-8.*
5. *Morros Viñoles C, Pérez Cuenca MD, Castillo Monsegur J, et al. Addition of phentanyl to mepivacaine in axil¬lary brachial plexus block. Effects on the anaesthetic and postoperative analgesic quality Rev Esp Anestesiol Reanim 1991;38:87-9.*
6. *Gobeaux D, Landais A, Bexon G, et al. Addition of phen¬tanyl to adrenalinized lidocainee for the brachial plexus block. Cah Anesthesiol 1987;35(3):195-9.*
7. *Kapral S, Gollmann G, Waltl B, et al. Tramadol added to mepivacaine prolongs the duration of an axillary brachial plexus blockade. Anesth Analg 1999; 88: 853-66.*
8. *Robaux S, Blunt C, Viel E, et al. Tramadol added to 1.5% mepivacaine for axillary brachial plexus block improves postoperative analgesia dose-dependently. Anesth Analg 2004;98:1172-7.*
9. *Crews JC, Weller RS, Moss J, James RL. Levobupivacaine for axillary brachial plexus block: a pharmacokinetic and clinical comparison in patients with normal renal func¬tion or renal disease. Anesth Analg 2002;95(1):219-23.*
10. *Liisanantti O, Luukkonen J, Rosenberg PH et al. High-dose bupivacaine and ropivacaine in axillary brachial plexus block. Acta Anaesthesiol Scand 2004;48:601-6.*
11. *Bardsley H, Gristwood R, Baker H, et al. A comparison of the cardiovascular effects of levobupivacaine and rac-bupivacaine following intravenous administration to healthy volunteers. Br J Clin Pharmacol 1998;46:245-9.*
12. *G. A. McLeod, D. Burke. Levobupivacaine. Anaesthesia 2001; 56: 331-341*
13. *Nishikawa K, Kanaya N, Nakayama M, et al. Fentanyl improves analgesia but prolongs the onset of axillary bra¬chial plexus block by peripheral mechanism. Anesth Analg 2000;91:384-7.*
14. *Fletcher D, Kuhlman G, Samii K, et al. Addition of phen¬tanyl to 1.5% lidocainee does not increase the success of axillary plexus block. Reg Anesth 1994;19:183-8.*
15. *Fanelli G, Casati A, Magistris L, et al. Phentanyl does not improve the nerve block characteristics of axillary brachial plexus anaesthesia performed with ropivacaine. Acta Anaesthesiol Scand 2001;45:590-4.*
16. *Raffa RB, Friderichs E, Reimann W, et al. Opioid and nonopioid components independently contribute to the mechanism of action of tramadol, an 'atypical' opioid an¬algesic. J Pharmacol Exp Ther 1992;260:275-85.*
17. *Altunkaya H, Ozer Y, Kargi E, et al. Comparison of local anaesthetic effects of tramadol with prilocaine for minor surgical procedures. Br J Anaesth 2003;90:320-2*
18. *Antonucci S. Adjuvants in the axillary brachial plexus blockade. Comparison between clonidine, sufentanil and tramadol. Minerva Anestesiol 2001;67:23-7.*
19. *Kaabachi O, Ouezini R, Koubaa W, et al .Tramadol as an adjuvant to lidocainee for axillary brachial plexus block. Anesth Analg 2009;108:367-70.*
20. *Kesimci E, Izdes S, Gozdemir M, et al. Tramadol does not prolong the effect of ropivacaine 7.5 mg/mL for axillary brachial plexus block. Acta Anaesthesiol Scand 2007;51:736-41.*
21. *Sarsu S, Mizrak A, Karakurum G. Tramadol use for axillary brachial plexus blockade. J Surg Res 2011;165:23-7*