Comparison of Different Doses and Concentrations of Bupivacaine and Lidocaine Combination for Infraclavicular Brachial Plexus Block

İnfraklaviküler Brakiyal Pleksus Bloğu İçin Bupivakain ve Lidokainin Farklı Doz ve Konsantrasyonlarının Karşılaştırılması

Sultan ACAR SEVİNÇ,[a]
Ayten SARAÇOĞLU,[a]
Olgaç BEZEN,[a]
Kemal Tolga SARAÇOĞLU,[a]
İbrahim Haluk KAFALI[a]

[a]Department of Anesthesiology and Reanimation,
İstanbul Science University
Faculty of Medicine, İstanbul

Geliş Tarihi/*Received:* 03.03.2016
Kabul Tarihi/*Accepted:* 28.06.2016

The abstract of this study was presented as a poster at 49. National Turkish Anesthesiology and Reanimation Society Congress, 2-6 December 2015, Antalya.

Yazışma Adresi/*Correspondence:*
Ayten SARACOGLU
İstanbul Science University
Faculty of Medicine,
Department of Anesthesiology and Reanimation, İstanbul,
TÜRKİYE/TURKEY
anesthesiayten@gmail.com

ABSTRACT Objectives: The aim of the study is to determine the duration of action and ideal effective doses of bupivacaine-lidocaine combination in different concentrations for infraclavicular brachial plexus block. **Material and Methods:** Patients were randomized into 3 groups, consisting of 20 patients and applied 15 mL 0.5% bupivacaine- 15 mL 2% lidocaine to the first, 15 mL 0.5% bupivacaine- 15 mL 2% lidocaine with 30 mL saline to the second, 10 mL 0.5% bupivakain- 10 ml 2% lidocaine with 40 mL saline to the third group. Onset and duration of motor and sensory blocks, additional analgesic requirements, postoperative Visual Analogue Scale scores were recorded. **Results:** Groups were similar according to demographics, time until operation after block, operation time, perioperative and postoperative mean arterial pressure, heart rates, SpO2 values. Initiation of sensory block time was significantly longer in Group 1 than the others. Motor block initiation time was significantly longer in Group 1 than the other groups. Postoperative sensory and motor block performance time was significantly shorter in Group 1 than the other groups. Additional analgesic requirement and Visual Analogue Scale scores were highest in Group 1 ($p<0.05$). **Conclusion:** In the current study we observed that by increasing the volume of local anesthetic solution, the time for initiation of sensory and motor block decreases and the duration of both sensory and motor block increases. We concluded that using decreased amount of bupivacaine-lidocaine combination to 60 mL, may cover the surgery and is efficient for postoperative analgesia.

Key Words: Anesthesia, conduction; orthopedic procedures; nerve block

ÖZET Amaç: Çalışmamızın amacı; infraklaviküler brakial pleksus blokajı ile gerçekleştirilen el cerrahisi operasyonlarında, farklı doz ve konsantrasyonlardaki Bupivakain-Lidokain kombinasyonlarının etkinlik sürelerini saptamak ve ideal ilaç dozunu belirlemektir. **Gereç ve Yöntemler:** Hastalar randomize olarak üç gruba ayrıldı (n=20). Birinci gruba 15 ml % 0,5 Bupivakain-15 ml %2 Lidokain (Grup 1), ikinci gruba 15 ml % 0,5 Bupivakain-15 ml %2 Lidokain-30 ml serum fizyolojik (Grup 2), üçüncü gruba 10 ml % 0,5 Bupivakain-10 ml %2 Lidokain- 40 ml serum fizyolojik uygulandı (Grup 3). Duysal ve motor blok başlangıç süresi, ek analjezik gereksinimleri, postoperatif Vizüel Analog Skala skorları kaydedildi. **Bulgular:** Gruplar demografik özellikler, blok sonrası operasyona başlama süresi, cerrahi süre, turnike süresi, peroperatif ve postoperatif ortalama arter basıncı, kalp tepe atımı ve SpO2 değerleri bakımından benzerdi. Grup 1'de duyusal blok başlama süresi diğer gruplardan anlamlı olarak daha uzundu. Grup 1'de motor blok başlama süresi diğer gruplardan anlamlı olarak daha uzundu. Ek analjezi ihtiyacı ve Vizüel Analog Skala skoru Grup 1'de en yüksekti ($p<0,05$). Grup 2 ve Grup 3'de ek analjezi ihtiyaçları benzerdi ($p>0,05$). **Sonuç:** Sonuç olarak lokal anestezik solüsyon hacminin artırılıp konsantrasyonlarının azaltılmasıyla blok başlangıcının hızlandırabildiği, süresinin uzatılabildiği, postoperatif hastalarda daha düşük VAS skorları ve daha az ek analjezik gereksinimi sağlandığı ortaya konulmuştur. Bupivakain-lidokain kombinasyonunun 60 mL'ye azaltıldığında bu etkinliği göstereceğini söyleyebiliriz.

Anahtar Kelimeler: Anestezi, kondüksiyon; ortopedik prosedürler; sinir bloğu

doi: 10.5336/anesthe.2016-51205

Turkiye Klinikleri J Anest Reanim 2016;14(3):84-9

Regional anesthesia is increasingly preferred today for minimizing the complications that can occur with general anesthesia and improving patient comfort.[1] As infraclavicular block allows earlier establishment of total blockade, working under tourniquet and achieves long-lasting postoperative analgesia, it is considered to have low risk and high availability both for patient and anesthesiologist.[2]

Earlier clinical studies on infraclavicular block compared various doses of lidocaine, but could not find a difference between the onset of blockage when 1%, 1.5% and 2% concentrations were used.[3] Another study reaching the minimum effective volume of lidocaine 1.5% with epinephrine 5 μg mL^{-1}, identified the minimum effective volume as 35 mL for single-injection ultrasound-guided infraclavicular block.[4] As indicated, there is a need for further dose-finding studies to determine the optimal dose and volume concentration of local anesthetics for brachial plexus blocks.

This study aimed to determine the efficacy and duration of action of different doses and concentrations of bupivacaine-lidocaine combination as well as the optimal dose in patients undergoing hand surgery under infraclavicular brachial plexus block.

MATERIAL AND METHODS

Following the approval of the Ethics Committee of our University, informed consent form was obtained from each patient. Routine systemic examinations were performed on outpatient basis and laboratory tests were performed. This study included 60 American Society of Anesthesiologists (ASA) I-II patients that were aged between 18 and 70 years and scheduled to have hand surgery after application of infraclavicular block under elective conditions. Patients already having a history of anticoagulant drug use, mental retardation, neurological deficit or neuropathy, and those that were allergic to local anesthetics were excluded from the study.

The patients were taken to the operating room 45 to 60 minutes earlier, and their blood pressure, heart rate and SpO_2 levels were monitored and recorded. The patients were administered 4 L min^{-1} oxygen via a facemask. Vascular access was achieved with IV cannula in dorsal surface of the hand, which was not going to be operated. All patients were given 0.03 mg kg^{-1} midazolam, 2 μg kg^{-1} fentanyl IV for premedication about 20 minutes before the surgery.

Patients were placed in supine position and their heads were turned towards the opposite side of where the block will be applied. Arm was in abduction; forearm was in 90 degree flexion, and hand was positioned at the level of umbilicus. The junction of the clavicle to the coracoid projection was palpated and marked as the point where peripheral block will be attempted. Electrocardiography electrode was placed in deltoid region within the side of the block. Surgical site was douched with povidone iodine and anesthetized locally using 2% lidocaine. While Stimuplex (B. Braun Melsungen, Germany) HNS 12 was preferred as nerve stimulator, Stimupleks A (B. Braun Melsungen, Germany) 22G, 100 mm was preferred as needle.

Anode and cathode terminals of the stimulator were connected to the ECG electrode in the deltoid muscle and block needle, respectively. Stimulator was set to 1.0 mA, 2 Hz, 0.1 ms parameters and twitching was searched by passing skin, subcutaneous tissue and pectoral muscle. Median nerve twitching was found, and continuation of twitching when the current intensity was decreased to 0.4 mA was considered as the indicator of successful location.

Patients were divided into 3 groups: Group 1 received 15 mL of 0.5% Bupivacaine-15 mL of 2% Lidocaine; Group 2 received 15 mL of 0.5% Bupivacaine-15 mL 2% Lidocaine with 30 mL of saline, and Group 3 received 10 mL of 0.5% Bupivacaine-10 mL of 2% Lidocaine with 40 mL of normal saline solution. The drug combination to be applied for each group was determined among three combinations via randomization method. Sealed opaque envelopes were used for randomization. Drug administration time was

recorded. After drug administration, sensory block was evaluated by applying pinprick test at 20-second intervals. The quality of motor block was assessed using Bromage scale and recorded.

The onset of motor and sensory block and time to complete blockage were recorded. Additionally, the heart rate, systolic-diastolic blood pressures, and oxygen saturation were monitored during the 0^{th}, 15^{th}, 30^{th}, 60^{th}, and 120^{th} perioperative minutes as well as the 30^{th}, 60^{th}, 120^{th} and 360^{th} postoperative minutes. When the surgery was completed, all patients were taken to the post-anesthesia recovery unit. The data recorded in the post-anesthesia recovery unit included the time to onset of postoperative pain, return of sensory and motor functions, and need for first analgesic. Moreover, severity of postoperative pain was evaluated with the visual analogue scala (VAS) score at the 30^{th}, 60^{th}, 120^{th}, 240^{th}, and 360^{th} minutes. Tramadol 1 mg/kg iv infusion was used as an additional analgesic agent for patients with a VAS score of 3 and more. The data were recorded by Dr. S.A.S.

STATISTICAL ANALYSIS

Statistical Package for Social Sciences (SPSS) 22.0 (IBM Corp, Armonk, NY, USA) was applied for statistical analysis. Quantitative data was analyzed using the ANOVA, Kruskal-Wallis and Mann-Whitney U tests. The Wilcoxon test was used for repeated measures. Qualitative data analysis was performed with the Chi-square test or the Fischer Test when the Chi-square test conditions could not be met.

RESULTS

One patient was excluded from the study because of inadequate sensorial block. The average age of the patients was 49.6 ± 19.0 years and the average weight was 73.9 ± 11.9 kg. There was no significant difference among the groups regarding demographical characteristics ($p > 0.05$) (Table 1).

The doses of preoperative midazolam and fentanyl did not show any significant difference among the patients of Group 1, Group 2 and Group 3 ($p > 0.05$). Additional analgesic requirement was significantly higher in Group 1 as compared to Group 2 and 3 ($p < 0.05$). However, the need for additional analgesia was not significantly different between Group 2 and Group 3 ($p > 0.05$) (Table 2).

The VAS score at the postoperative 6^{th} hour was significantly higher in Group 1 (2.6±0.8) compared to Group 2 and 3 ($p < 0.01$). Also, VAS score at the postoperative 6^{th} hour in Group 3 was significanty higer than Group 2 (1.2±1.1 vs 0.2 ± 0.4, respectively, $p < 0.05$).

The time to onset of sensory block was signficantly longer in Group 1 as compared to Group 2 and Group 3 ($p < 0.05$). Additionally, the time to onset of sensory block was significantly longer in Group 2 than in Group 3 ($p < 0.05$) (Table 3). The time to onset of motor block in Group 1 was significantly longer than in Group 2 and Group 3 ($p < 0.05$). Nevertheless, the time to onset of motor block did not show any significant difference between Group 2 and Group 3 ($p > 0.05$) (Table 3).

There was no significant difference among groups regarding the time to start surgery after

TABLE 1: Demographic characteristics of groups.

		Group 1 mean±SD, n (%)	Group 2 mean±SD, n (%)	Group 3 mean±SD, n (%)	p
Age (years)		49.6±19.0	41.5±17.7	37.7±19.8	0.143
Weight (kg)		73.9±11.9	74.9±15.1	72.7±12.6	0.879
ASA	I	12 (60%)	12 (60%)	16 (84%)	0.177
	II	8 (40%)	8 (40%)	3 (16%)	

ANOVA/ Kruskal Wallis test.
ASA: American Society of Anesthesiologists.

TABLE 2: Additional analgesic requirement with preoperative midazolam and fentanyl doses.

		Group 1 mean±SD, n (%)	Group 2 mean±SD, n (%)	Group 3 mean±SD, n (%)	p
Additional analgesic requirement	No	10 (50%)*	20 (100%)	16 (84%)	***0.001***
	Yes	10 (50%)*	0 (0%)	3 (16%)	
Midazolam (mg)		2.2±0.3	2.3±0.4	2.2±0.4	0.384
Fentanyl (mcg)		74.0±11.9	74.8±15.3	71.3±13.1	0.709

*: Between Group 1 and 2, between Group 1 and 3.
ANOVA/Kruskal Wallis test.

TABLE 3: Comparison for the time to onset of sensory and motor block with duration of surgery and tourniquet.

	Group 1 mean±SD	Group 2 mean±SD	Group 3 mean±SD	p
Onset of sensory block (sec)	158.4±20.4*	106.2±32.2°	79.6±41.0	***≤ 0.001***
Onset of motor block (sec)	209.3±34.3*	141.4±30.5	120.8±45.6	***≤ 0.001***
Time to start surgery after blockage (min)	24.8±5.7	25.9±7.6	28.5±6.9	0.279
Duration of surgery (min)	34.0±14.1	52.3±34.5	46.9±33.3	0.463
Duration of tourniquet (min)	35.3±16.8	48.3±31.2	36.9±26.2	0.434

*: Difference between Group 1 and 2, between Group 1 and 3. °: Difference between Group 2 and 3. Kruskal Wallis test/Mann Whitney U test.

achival of blockage, duration of operation and duration of tourniquet ($p>0.05$) (Table 3). No significant difference was detected among groups regarding the heart rate measured at 0^{th}, 15^{th}, 30^{th}, and 60^{th} perioperative minutes ($p>0.05$).

In all groups, perioperative heart rate showed a significant decrease at the 15^{th}, 30^{th}, and 60^{th} minutes as compared to the value at the 0^{th} minute ($p<0.05$); however, the change in heart value did not show a significant difference among the three groups ($p>0.05$). No statistically significant difference was detected between groups in terms of the heart rate recorded at the 30^{th}, 60^{th}, 120^{th} and 360^{th} postoperative minutes ($p>0.05$).

Mean arterial pressure (MAP) measured at the 0^{th}, 15^{th}, and 30^{th} perioperative minutes did not show any significant difference in all groups ($p>0.05$). However, MAP at the 60^{th} perioperative minute was significantly higher in Group 2 (78.9±8.8 mmHg) in comparison with Group 1 (71.7±6.6 mmHg) and 3 (72.6±5.4 mmHg) ($p< 0.05$). In all groups, MAP values measured at the perioperative 15^{th}, 30^{th}, and 60^{th} minutes showed significant difference compared to the value of 0^{th} minute ($p< 0.05$). However, the change in MAP value was not significantly different among groups ($p >0.05$).

The change in perioperative SpO_2 values did not show any significant difference between groups ($p >0.05$). The time for dissolution of sensory and motor blockade in postoperative period was significantly shorter in Group 1 in comparison with Group 2 and 3 ($p< 0.05$). Additionally, the time to dissolution of sensory and motor blockade in postoperative period was significantly shorter in Group 3 than Group 2 ($p< 0.05$) (Table 4).

DISCUSSION

In this prospective, randomized study, we used the combination of 0.5% bupivacaine and 2% lidocaine in different concentrations and volumes for hand surgeries performed under infraclavicular brachial plexus block. When the concentration was decreased while increasing the volume, sensory block started earlier, lasted longer and delayed dissolution of sensory and motor blockade was occured. Besides when the concentration was decreased with the same volume, the time to

TABLE 4: Comparison for the time to dissolution of sensorial and motor block.

	Group 1 mean±SD	Group 2 mean±SD	Group 3 mean±SD	p
Time to dissolution of sensory block (min)	285.9±27.4*	399.5±50.6°	350.1±43.4	≤ ***0.001***
Time to dissolution of motor block (min)	330.5±27.3*	434.3±49.0°	396.3±47.0	≤ ***0.001***

*: Difference between Group 1 and 2, between Group 1 and 3. °: Difference between Group 2 and 3. Kruskal Wallis test/Mann Whitney U test.

dissolution of sensory and motor blockade in postoperative period was significantly shorter in low concentration group. Moreover, the need for additional analgesics and the VAS scores were observed lower.

Differences in materials and methods, variation of local anesthetics and solution components (e.g. adding sodium, bicarbonate, or adrenaline), volume of local anesthetics, and experience of practitioner may produce different results related to duration of block application and time to onset of blockade.[5]

Kilka et al. performed a clinical study examining infraclavicular block administering 1% prilocaine + 0.5% bupivacaine combination in 175 patients and reported to have achieved successful blockade at a rate of 94.8% as well as postoperative analgesia lasting nearly for 8 hours. As infracla vicular block allows earlier establishment of total blockade, working under tourniquet, and achieves long-lasting postoperative analgesia, it is considered to have low risk and high availability both for the patient and anesthetist.[6,7] The reason why we administered lidocaine in addition to bupivacaine was to accelerate the onset of blockade. Also, no patient experienced tourniquet pain.

Rucci et al. randomly divided the patients, who were scheduled for orthopedic upper limb surgery, into three groups and achieved axillary brachial plexus block by applying 20, 30, 40 mL local anesthetics (the mixture prepared with equal amounts of 0.5% bupivacaine, 1: 200,000 epinephrine and 2% lidocaine).[8] In this study, they concluded that success rate of blockade was higher in groups where 30 and 40 mL local anesthetic was administered.

In their study Arcand et al., used 0.5 mL kg^{-1} (max. 40 mL) local anesthetic and Koscielniak et al. used 0.5 mL kg^{-1} (30-50 mL) local anesthetic.[9,10] Sandhu et al., however, reported that they obtained successful results using 21 mL local anesthetics in total. In the current study, we used 30 mL and 60 mL local anesthetics in different concentrations.[8-11] Risk of systemic toxicity especially rises in case of advanced age, poor health, liver and kidney failure and pregnancy. Therefore, volume is kept as low as possible in the studies with the aim of achieving a successful blockade.

Vester-Andersen et al. divided their patients randomly into three groups and administered three different volumes- 40, 50, and 60 mL of 1% mepivacaine with epinephrine 1:200,000 to establish perivascular axillary block using a catheter technique.[12] In that study, no significant difference developed between the three groups regarding sensory and motor blockade; however, the quality of sensory block was observed to be better in high volume groups (50, 60 mL) as compared to low volume (40 mL) group. Further more, another study applying axillary block with local anesthetic in the same amount but different volumes the quality of sensory block was better in high volume group than in low volume group.[13] The primary goal of this study was to indicate the relation of the quality of motor and sensory block to the concentration and volume of a local anesthetic. By applying the same volume and keeping the dose of analgesic low, we investigated whether it would have the same efficacy or not. According to statistical and clinical results, when Group 1 and Group 2 were compared, motor and sensory block duration extended when we applied increased volume for the same dose and increased

volume of local anesthetic. When we compared Group 2 and Group 3, the time to dissolution of sensory and motor block was longer in Group 2.

Although ultrasonography has now become a widely used technique for peripheral nerve blocks, it was not used for this study. This is one of limitations of this study.

CONCLUSION

In the present study we observed that in the Group where we administered the same drug dose with increased volume, the postoperative pain and additional analgesic requirement decreased; the time to onset of motor and sensory block shortened; and the time to recovery from sensory and motor block in postoperative period extended. In other words, efficacy of anesthesia and analgesia increased in cases that received the same drug dose in higher volumes.

Additionally, we concluded that if we reduce the drug dose but use the same volume, we may be able to keep away from toxic concentrations. In the cases, where we reduced the drug dose in equal volume, duration of motor and sensory block became shorter; VAS scores scaled up at the 6th postoperative hour and patients required additional analgesia earlier. However, the patients did not feel any pain during the surgery and the following 6 hours. As a result, it was found to be sufficient for surgery to reduce the dose of local anesthetics while keeping the volume high.

REFERENCES

1. Hingorani AP, Ascher E, Gupta P, Alam S, Marks N, Schutzer RW, et al. Regional anesthesia: preferred technique for venodilatation in the creation of upper extremity arteriovenous fistulae. Vascular 2006;14(1):23-6.
2. Chin KJ, Alakkad H, Adhikary SD, Singh M. Infraclavicular brachial plexus block for regional anaesthesia of the lower arm. Cochrane Database Syst Rev 2013;(8): CD005487.
3. González AP, Bernucci F, Techasuk W, Pham K, Finlayson RJ, Tran DQ. A randomized comparison between 3 combinations of volume and concentration of lidocaine for ultrasound-guided infraclavicular block. Reg Anesth Pain Med 2013;38(3):206-11.
4. Tran DQ, Dugani S, Dyachenko A, Correa JA, Finlayson RJ. Minimum effective volume of lidocaine for ultrasound-guided infraclavicular block. Reg Anesth Pain Med 2011;36(2):190-4.
5. Fredrickson MJ, Patel A, Young S, Chinchanwala S. Speed of onset of 'corner pocket supraclavicular' and infraclavicular ultrasound guided brachial plexus block: a randomised observer-blinded comparison. Anaesthesia 2009;64(7):738-44.
6. Kilka HG, Geiger P, Mehrkens HH. [Infraclavicular vertical brachial plexus blockade. A new method for anesthesia of the upper extremity. An anatomical and clinical study]. Anaesthesist 1995;44(5):339-44.
7. Neal JM, Gerancher JC, Hebl JR, Ilfeld BM, McCartney CJ, Franco CD, et al. Upper extremity regional anesthesia: essentials of our current understanding, 2008. Reg Anesth Pain Med 2009;34(2):134-70.
8. Rucci FS, Barbagli R, Pippa P, Boccaccini A. The optimal dose of local anaesthetic in the orthogonal two-needle technique. Extend of sensory block after injection of 20, 30 and 40 mL of anaesthetic solution. Eur J Anaesthesiol 1997;14(3):281-6.
9. Arcand G, Williams SR, Chouinard P, Boudreault D, Harris P, Ruel M, et al. Ultrasound-guided infraclavicular versus supraclavicular block. Anesth Analg 2005;101(3): 886-90.
10. Koscielniak-Nielsen ZJ, Frederiksen BS, Rasmussen H, Hesselbjerg L. A comparison of ultrasound-guided supraclavicular and infraclavicular blocks for upper extremity surgery. Acta Anaesthesiol Scand 2009;53(5): 620-6.
11. Sandhu NS, Capan LM. Ultrasound-guided infraclavicular brachial plexus block. Br J Anaesth 2002;89(2):254-9.
12. Vester-Andersen T, Husum B, Lindeburg T, Borrits L, Gøthgen I. Perivascular axillary block IV: blockade following 40, 50 or 60 mL of mepivacaine 1% with adrenaline. Acta Anaesthesiol Scand 1984;28(1):99-105.
13. Martin R, Dumais R, Cing-Mars S, Tétrault JP. [Axillary plexus block by simultaneous blockade of several nerves. I. Influence of the volume of the anesthetic solution]. Ann Fr Anesth Reanim 1993;12(3):229-32.