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Evaluation of the Effect of Local Anesthetic Volume and Patient Age on Brachial Plexus Block with Axillary Approach

Aksiller Yaklaşımla Yapılan Brakial Pleksus Bloğunda Hasta Yaşı ve Lokal Anestetik Hacminin Etkisinin Değerlendirilmesi

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SUMMARY

Objectives: *Ageing induces functional changes in the nerves, and larger volumes of local anesthetic provide better quality sensory block than smaller volumes. Consequently, the effects of local anesthetics were retrospectively researched in young and old age groups, based on the different volumes of local anesthetics used.*

Methods: *Sensory and motor block was performed by nerve stimulator, and block formation and recovery times of 104 patients were assessed retrospectively. Patients were divided into two main groups as <35 y (Group A) and >55 y (Group B), and then into two subgroups as those with <30 ml or >30 ml local anesthetic administered. Evaluations were conducted based on these groups.*

Results: *The length of time for the sensory and motor block formation was shorter in Group B patients compared to Group A patients in the <30 ml group (p<0.05). In Group B patients, the block formation was also significantly faster in those given <30 ml local anesthetic compared to those who were given >30 ml (p<0.05).*

Conclusion: *Lower local anesthetic volumes accelerate sensory and motor block formation time in older patients but not in younger patients. Higher local anesthetic volumes delay sensory and motor block recovery time in younger patients but not in older patients.*

Key words: *Age; brachial plexus block; local anesthetic volumes.*

ÖZET

Amaç: Yaşlanma sinirlerde fonksiyonel değişikliğe neden olmaktadır. Yüksek miktardaki lokal anestezik düşük miktardaki lokal anestezikten daha kaliteli blok sağlar. Bu yazıda, genç ve yaşlı yaş gruplarında farklı hacimlerde kullanılan lokal anesteziklerin etkileri geriye dönük olarak, araştırıldı.

Gereç ve Yöntem: Yüz dört hastanın duyusal ve motor blok oluşumu ve derlenme süreleri retrospektif olarak değerlendirildi. Hastalar <35 yaş (Grup A) ve >55 yaş (Grup B) olarak iki ana gruba, daha sonra (Grup A) <30 ml veya >30 ml lokal anestezi uygulanan iki alt gruba ayrıldı. Değerlendirmeler bu gruplara dayanarak yapıldı.

Bulgular: Duyusal ve motor blok oluşumu zamanı A grubu hastalar ile karşılaştırıldığında B grubu hastalarda <30 ml grupta daha kısa bulundu (p<0,05). B grubu hastalarda blok oluşumu <30 ml lokal anestezik verilen grupta >30 ml verilen gruba göre anlamlı olarak daha hızlı idi (p<0,05).

Sonuç: Düşük lokal anestezik hacimleri yaşlı hastalarda gençlere göre duyu ve motor blok oluşma zamanını hızlandırır. Yüksek lokal anestezik hacmi genç hastalarda yaşlı hastalara göre duyu ve motor blok çözülme süresini geciktirmektedir.

Anahtar sözcükler: Yaş; brakiyal pleksus bloğu; lokal anestezik hacmi.

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INTRODUCTION

Peripheral nerve blocks are widely used [1,2] in upper extremity surgery with high success rates. Compared to single nerve stimulation techniques, multiple nerve stimulation techniques increase the rate of complete sensory blocks.[3,4] There are many factors which affect the rate of motor or sensory blockade duration, or the length of time to get the block established. Fiber diameter, degree of myelination, myelin thickness, internode distance, size and specific membrane properties of the node of Ranvier, characteristics of the extracellular milieu, and nerve temperature are among factors that are listed.[5] Aging is an important factor, inducing functional changes in the nerves. Especially, peripheral myelinated fibers are affected by the decreased nerve conduction velocity due to aging.[6]

We hypothesized that the efficacy of axillary block might be changed as patients get older, because of a downward functional change in the related nerves. This study aimed to retrospectively evaluate the block efficacy in orthopedic upper extremity surgery patients of different age groups. These patients had brachial plexus blockade with axillary approach and multiple nerve stimulation. However, in this retrospective study, after recognizing the importance of variable dose or volume applied, we revised the research method as the volume or dose of local anesthetic administered was taken into consideration.

MATERIALS AND METHODS

After approval of the local ethics committee, records from 104 patients between November 2008 - March 2009, who were between the ages 18 and 75, whose physical condition was ASA I-II, who had hand and forearm surgery using multiple injection technique and brachial nerve block with axillary approach at Ege University Orthopedics and Traumatology Clinic were evaluated. Patients who had neuromuscular and psychiatric disorders, who did not want the block, who had allergies to local anesthetic, diabetes mellitus, central and peripheral nerve disease, who did not fall into the proper age group, who had venous or arterial puncture occurring during the block, paresthesia or pain, who received fentanyl due to tourniquet or incision pain due to operation and those who had to have general anesthesia using laryngeal mask application were excluded from the study.

The age, gender, height, weight, ASA status and elective surgery of patients who had peripheral nerve block were recorded. 22 Gauge 50 mm stimuplex needle (Stimuplex D.B. Braun Medical) with nerve stimulator (Stimuplex HNS11, B Braun medical Germany) was used at 1 mA current, 2 Hz frequency and 0.1 ms velocity; after median and musculocutenous, radial and ulnar nerve response were obtained the stimulation was reduced to 0.3-0.5 mA in all distributions. When the motor response was observed to continue without a decline, a local anesthetic, prepared as 0.5% bupivacaine + 2% prilocaine mixture (equal amount) was administered as intermittent doses, not exceeding 40 ml. Based on the nerve responses; sensory block onset time (pinprick test and cold test), motor block formation time (0 = normal movement, 1 = incomplete motor block, 2 = complete motor block), the time for motor block to recover (time passed from the formation of motor block until complete recovery of extremity strength to move) and time for sensory block to recover (time passed from the moment sensory block is formed until the patient starts feeling pain in the operated extremity) were evaluated based on patient records.

The patients were divided into two main groups as <35 years (Group A) and >55 years (Group B) then into two subgroups who had >30 ml or <30 ml of local anesthetic administered and evaluations were conducted based on these groups. In order to prevent patients with similar age distribution to get into same group, a 20 year difference between the two groups was found to be appropriate.

The data was tested for normal distribution using Shapiro-Wilk test. The non-parametric Mann-Whitney U test was used due to the non-homogeneous distribution of the data. Descriptive statistics are given as median (M) ± Interquartile Range (IR). The statistical significance threshold (p value) is 0.05.

RESULTS

Demographic data from 104 retrospectively studied patients (there were 55 patients in group A;

Table 1. Demographic data in both groups

	Age (year)	Length (cm)	Weight (kg)
Group A	25±12*	170±14	65±13
Group B	59±8	164±13	74±12

* p<0.05.

Table 2. The volume of local anesthetic given to patients group A and B

	Group A	Group B
30 ml ↑	37.0 ml*	36.84 ml*
30 ml ↓	27.2 ml	27.1 ml

* p<0.05.

39 of them were >30 ml but 16 of them were <30 ml. There were 49 patients in group B; 25 of them were >30 ml but 24 of them were <30 ml) who had hand and forearm surgery using axillary block with multiple stimulation technique, is summarized in Table 1. The median local anesthetic quantity administered to patients at various age intervals are shown in Table 2.

The relationship between the durations of sensory and motor block formation, and time for sensory and motor block to recover are shown in Table 3. The duration of the sensory and motor block formation was shorter in Group B patients compared to Group A patients when the volume of local anesthetic was <30 ml ($p<0.05$). In Group B, the block formation was also significantly faster in those given <30 ml local anesthetic compared to those who were given >30 ml ($p<0.05$). In Group A, although the time for sensory block recovery was longer in those who had >30 ml of local anesthetic compared to those who had <30 ml of anesthetic, it did not reach significant difference ($p=0.06$). There is no difference between Group A and B patients with <30ml local anesthetic, based on the sensory block recovery ($p=0.079$)

DISCUSSION

Based on our findings the volume of local anesthetic in patients <35 years did not affect sensory and motor block formations and recovery times. However in patients over 55 years if the volume of local anesthetic was lower 30 ml, the sensory and motor block formations time was smaller compared to local anesthetic >30 ml

In the peripheral nerves, age-dependent electrophysiological and histological changes arise.[7] As a result of these changes, along with ageing; decreased nerve conduction velocity, decreased combined muscle action potential amplitude and lengthening in the

Table 3. Data regarding sensorial and motor block in group A, B

	Group A (M±IR)	Group B (M±IR)	p
Motor block formation time (minute)			
30 ml ↑	10±4	15±9	0.65
30 ml ↓	11±7	8.50±3	0.054
p	0.29	0.02*	
Sensory block formation time (minute)			
30 ml ↑	8 ± 3	10 ± 6	0.107
30 ml ↓	9.50 ± 6	6.50 ± 3	0.034*
p	0.375	0.03*	
Motor block recovery time (minute)			
30 ml ↑	570±120	555±150	0.291
30 ml ↓	555±80	571.5±180	0.713
p	0.114	0.865	
Sensory block recovery time (minute)			
30 ml ↑	690±120	660±140	0.363
30 ml ↓	625±90	720±218	0.079
p	0.06	0.588	

M: Median, IR: Interquartile Range; * p<0.005.

distal latency takes place.[8] The decrease in the nerve conduction velocity has been tried to be explained by the decrease in the nerve fiber diameter and changes in the fiber membrane.[9] The age-dependent changes in nerve morphology and conduction cause the nerve axon to have an increased sensitivity to local anesthetics.[10,11] In this study, while the effects of local anesthetics were researched on young and old age groups, due to the difference in volumes of anesthetics used, which were obtained retrospectively, the relationship between two patient groups of different ages and two different volumes (>30 ml and <30 ml) were also evaluated. In their study, Vester-Andersen et al.[12] also states that better quality of sensory block is obtained with higher volumes, in addition to other studies which have also shown that for the same amount of local anesthetic, the larger volumes provided better quality sensory block than smaller ones.[13,14] However, in the study by A. Serradell et al.[15] where they used three different volumes (36 ml, 28 ml, 20 ml), motor and sensory block formation were determined to be faster in the group that received a lower volume, although they could not state the reason for this finding. In this study, although the administration of low or high volume in the young patient group did not create a difference in the motor and sensory block formation, low volume administration in older patients accelerated motor and sensory block formation compared to higher volumes. We suggest that this is related to the hydrostatic pressure between epineuria and perineurium due to the administration of the local anesthetic. Since there is an age-dependent decrease of connective tissue elasticity,[16] the low volume of the local anesthetic administered between the epineuria and perineurium in older patients can possibly cause more hydrostatic pressure in the nerve tissue. Due to pressure, anesthetics can easily get away from the perineurium or target points.[17,18] In young patient groups, the reason for the volume not accelerating the blockade initiation may be related to the preservation of the epineuria elasticity that disappears with age, thus the pressure does not increase as much as it does in the elderly, even when a high volume is used.

We find that motor block recovery duration does not change in either age group based on the volume although increased volume delays sensory block recovery in younger patients. In younger patients the spread of high volume local anesthetic to a larger area between the epineuria and the perineurium due to the preserved elasticity might be the reason for this delay. We cannot confirm that low volume delays sensory block recovery in older patients compared to younger ones (the increase in the number of the patients in the study groups may further decrease p value of 0.079). It is also uncertain that low hydrostatic pressure caused by low volume might be some what ineffective because of the increased local anesthetic sensitivity in the elderly.

Our study design is retrospective study and it is the major drawback of our study. However future prospective studies are needed identify whether if aging influences block qualities during regional anesthesia.

CONCLUSION

The increase in the volume of local anesthetic administered delays sensory and motor block formation in older patients due to age-dependent changes in nerve structure. These changes might be related to an age-dependent decrease of connective tissue elasticity, which may give raised to an increase in hydrostatic pressure in the neural sheath during local anesthetic injection in the elderly. The use of the low volume accelerated the sensory and motor block formation time in older patients compared to younger ones, while the use of high volume local anesthetic (without changing the concentration) only delays the sensory block recovery in the younger patients.

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