PERIODICUM BIOLOGORUM
VOL. 117, No 2, 287–290, 2015

UDC 57:61
CODEN PDBIAD
ISSN 0031-5362

Effects of age on onset time and duration of sensory blockade in ultrasound guided supraclavicular block

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Abbreviations:

US-SCB,	supraclavicular brachial plexus block
LA,	local anesthetic
BP,	brachial plexus
CSA,	cross sectional area

Received April 10, 2015.

Abstract

Background and Purpose: *Involutive changes of brachial plexus occur with aging. The aim of this study was to determine if these changes would effect onset time and duration of sensory blockade in all four distal nerves of brachial plexus in middle aged (<50 years) and elderly patients (>65 years).*

Materials and Methods: *Middle aged (N=22) and elderly patients (N=22) undergoing upper limb surgery received an ultrasound guided supraclavicular block with a mixture of local anesthetics (50 : 50, 0.5% levobupivacaine, 2% lidocaine). The prospective, observer-blinded study method is a previously validated step-up/step-down sequential model where the local anesthetic volume for each following patient is determined by the outcome of the previous block. The starting volume was 30 ml. Only the blocks with complete sensory blockade in all four regions of distal nerves were analyzed for the onset time and duration of sensory blockade.*

Results and Conclusions: *The mean (SD) block onset time was 25.8±0.6 min and the mean (SD) block duration was 151.5±8.9 min in the entire middle aged group. In the entire elderly group, the mean (SD) block onset time was 21±0.82 min and the mean (SD) block duration was 195.75±14.99 min. The difference in both, onset time and duration was significant (P=0.0002, 95%CI 3.352–6.248; P=0.0023, 95% CI 65.63–22.95, respectively). In conclusion, local anesthetics have a faster onset time and longer duration of sensory blockade in elderly due to alterations of peripheral nerves and increased sensitivity to local anesthetics.*

INTRODUCTION

Ultrasound-guided supraclavicular brachial plexus block (US-SCB) is widely used for upper extremity surgery as it enables anesthesia of all four distal upper extremity nerve territories (the median, radial, ulnar and musculocutaneous) at the level of the clavicle *(1).* Several mechanisms may account for the increased sensitivity of elderly population (>65 years) to local anesthetic agents in peripheral blocks. Conduction velocities, number of large diameter fibers and activity of peripheral nerve (Na+, K+) ATPase all decrease with age. Hence, smaller doses of local anesthetic (LA) agents are required for regional blocks in elderly patiens *(2).* Global involutive changes in elderly population affect brachial plexus (BP) resulting in lower anesthetic volume required for effective US-SCB *(3).* Involutive changes of BP, assessed by measuring the cross-sectional area (CSA) of BP at the first rib, result in significantly smaller CSA in elderly patient as compared with younger patient (0.60±0.08 cm^2 vs 0.91±0.13 cm^2). The study of Paqueron and colleagues analyzed influence of age on peripheral nerve blocks *(4)*. They found a positive relationship between age and the duration of a complete sensory blockade. Approximately a 2.5-time longer duration of complete sensory block in the elderly is observed in comparison with young patients indicating that LA agents administered in peripheral nerve blocks have a dramatically different effect on the elderly population. However, they employed ropivacaine, local anesthetic with different pharmacodynamic profile than local anesthetics used in our study. Additionaly, Paqueron et al. analyzed a different type of peripheral block in their study (mid-humeral block). Increased sensitivity to local anesthetics administered for peripheral nerves blocks in elderly in addition to structural changes of brachial plexus led us to believe that sensory block onset time as well as duration of block for each distal nerve of brachial plexus in elderly would be different in comparison with middle aged patients. We hypothesized a shorter onset time and loger duration of sensory blockade in elderly patients.

MATERIAL AND METHODS

After we obtained an approval from Hospital Ethics Committee as well as a written informed consent from every participant, we recruited 22 elderly patients (>65 years) undergoing upper limb surgery to this observer blind, up–down sequential allocation study. We registered the study with ClinicalTrials.gov and were issued number NCT01467596. Exclusion criteria were the patient's refusal of regional anesthesia, any neurologic or neuromuscular disease, diabetes and clinical signs of cutaneous infection at the site of needle insertion. Patients received no premedication before arrival in the operating room and standard monitoring equipment (EKG, non-invasive blood pressure measurement, pulse oximetry) was used during the performance of supraclavicular brachial plexus block. Prior to US-SCB we infiltrated the skin with LA and administered 25 mcg of fentanyl intravenously. We placed a 25 G spinal needle (90 mm, Quincke type, Vygon, France) on the outer (lateral) end of the probe and advanced it along the long axis of the probe in the same plane as the ultrasound beam (in plane technique). We observed the needle movement in real time. Once the needle tip reached the brachial plexus cluster on the ultrasound image, injected the mixture of LA. After administering half of the determined LA volume in „pocket corner", we repositioned the needle cranially toward the neural cluster in order to apply the other half ofthe LA. For the purposes of block assessment, we defined time zero as the time of removal of the needle from the skin. Sensory block onset time for each distal nerve was recorded in 5 minutes intervals during the first 30 minutes after time zero. An observer blinded to volume of administered LA checked for pinprick anesthesia (to a 23-gauge needle) and loss of cold sensation (by the applying an alcohol swab) every 5 min for up to 30 min in the central sensory region of each nerve locations (the median, ulnar, radial and musculocutaneous nerve) in comparison with the same stimuli delivered to the contralateral arm. Duration of sensory blocks for every distal nerve was tested in 30 minutes intervals after surgical completion only for patients with successful blocks. A successful block is defined as complete sensory blockade (total loss of pinprick sensation and total loss of cold sensation) in all four regions of distal nerves assessed within 30 min of local anesthetic injection. The duration of sensory blockade was calculated from onset time to the time of full recovery in all four distal nerves. The starting volume of LA mixture was 30 ml. After a successful block was achieved, the subsequently recruited patient received a reduced LA volume of 5 ml. Otherwise, if complete sensory blockade in any of the distal nerve distributions did not appear, the block was declared as unsuccesful, and the next recruited patient received a volume of LA increased by 5 ml. No further data were obtained from patients with unsuccesful blocks. Unless otherwise stated, the data are expressed with mean ±SD. The unpaired t-test with Welch correction was used to test for the statistically significant differences in mean between the groups. Calculations were performed by software package StatSoft, Inc. (2011), STATISTICA, version 9.1, (Tulsa, OK, USA).

RESULTS

Twenty-two patients completed the study protocol. Appropriate ultrasound visualization of BP at first rib was achieved in all patients. The study group baseline characteristics are shown in Table 1. For the middle-aged patients, the administered volumes of LA ranged from 35 to 10 ml (mean 20 ml). Ten patients in the middle-aged group had a failed block. One patient had incomplete anesthesia in the radial nerve territory. Two patients had failed block in the median nerve and one in the ulnar and median nerve distribution, respectively. Of the six remaining patients with failed block, five had incomplete

TABLE 1

Baseline patient characteristics.

	Elderly group (*n* = 22)	Middle-aged group (*n* = 22)
Age (years)	74.7±7.1	41.6±5.9
BMI (kg/m^2)	26.5±3.5	25.9±2.9
Male/female (*n*)	8/14	13/9
ASA I/II/III/IV (*n*)	0/5/14/3	7/14/1/0
Operated side L/R (*n*)	13/9	8/14
Duration of surgery (min)	76.1±33.9	89.6±33.8

Data are expressed as mean ± standard deviation or *n* (number of patients).
ASA, American Society of Anesthesiologists; BMI, body mass index; L/R, left/right.

TABLE 2

Sensory block characteristics-onset time.

Onset time (min) (<45 g.)		(>65 g.)	N¶ (<45 g.)	(>65g.)	P	95% CI (Confidence interval)
UL N	26.5±3.5	22.5±3.1	16	18	0.0013	1.69–6.30
MDN	25.0±3.3	20.2±3.0	19	20	0.0001	2.78–6.81
RN	25.7±4.0	20.7±4.7	21	20	0.0007	2.24–7.75
MCN	25.9±3.8	20.6±4.6	21	17	0.0004	2.53–8.06
+Group	25.8±0.6	21.0±1.0	4	4	0.0002	3.35–6.24

Data are expressed as mean ± standard deviation or *n* (number of patients).
+ Group (mean ± standard deviation of onset time for the entire group).
¶ N, number of patients with complete sensory blockade in distal nerve territory.
ULN, ulnar nerve
MDN, medial nerve
RN, radial nerve
MCN, musculocutaneous nerve

TABLE 3

Sensory block characteristics-duration of sensory blockade.

Duration of sensory blockade (<45 g.)		(>65 g.)	N¶ (<45 g.)	(>65g.)	P	95% CI (Confidence interval)
ULN	164.6±15.1	213.5±25.8	12	13	0.0001	66.59–31.21
MDN	147.1±23.1	192.7±27.0	12	13	0.0002	24.72–66.47
RN	144.6±23.8	177.3±27.1	12	13	0.004	11.52–53.88
MCN	149.6±24.4	199.6±26.1	12	13	0.0001	29.05–70.95
+Group	151.5±8.9	195.7±15.0	4	4	0.0023	65.63–22.95

¶ N, Number of patients with complete sensory blockade in all four distal nerve territory.
+ Group (mean ± standard deviation of onset time for the entire group).
ULN, ulnar nerve
MDN, medial nerve
RN, radial nerve
MCN, musculocutaneous nerve

block in the ulnar and one in musculocutaneous nerve territory, respectively. For the elderly patients, the administered volumes ranged from 30 to 5 ml (mean 14 ml). Nine patients had a failed block. Sensory block failed in ulnar nerve distribution in two patients, in musculocutaneous nerve distribution in three patients, in ulnar and radial nerve distribution in one patient, in musculocutaneous and median nerve distribution in one patient, in median and radial nerve distribution in one patient and in ulnar and musculocutaneous nerve distribution in one patient. Characteristics of the sensory blockade between the tested groups are shown in Table 2 and 3. For the entire middle-aged group, the mean (SD) block onset time was 25.8± 0.6 min and the mean (SD) block duration was 151.5±8.9 min. The mean (SD) block onset time was 26.5±3.5, 25.0±3.3, 25.7±4.0, 25.9±3.8 for the ulnar, median, radial and musculocutaneous nerve, respectively. The mean (SD) block duration time was 164.6±15.1, 147.1±23.1, 144.6±23.8, 149.6±24.4 for the ulnar, median, radial and musculocutaneous nerve, respectively. For the entire elderly group, the mean (SD) block onset time was 21±0.82 min and the mean (SD) block duration was 195.75± 14.99 min. The mean (SD) block onset time was 22.5±3,09, 20.25±3.02, 20.75±4.66, 20.58±4.63 for the ulnar, median, radial and musculocutaneous nerve, respectively. The mean (SD) block duration time was 213.46±25.77, 192.69±26.97, 177.31±27.12, 199.61±26.17 for the ulnar, median, radial and musculocutaneous nerve, respectively. The difference between onset time of the entire groups as well as every distal nerve and duration of sensory blockade of entire groups as well as every distal nerve was statistically significant, as shown in Table 2 and 3.

DISCUSSION

The present study demonstrated that a LA agents have a faster onset and longer duration of sensory blockade in elderly patients. Both alterations of peripheral nerves propeties due to ageing as well as increased sensitivity of elderly on LA agents might explaine these results *(2, 5)*. Paqueron et al. analyzed influence of age on peripheral nerve blocks and they found a positive relationship between age and duration of complete sensory blockade. The similarities between present and the study of Paqueron are outcomes that we analyzed (onset time and duration of sensory blockade). Hovewer, our results do not entirely confirm theirs as we found a faster onset time (22 vs. 27.5 min) and a shorter duration of sensory blocks (196 vs. 390 min) in distal nerves of BP in elderly population. Different LA (ropivacaine vs. mixture of levobupivacaine and lidocaine) as well as type of brachial plexus block (mid-humeral block vs. supraclavicular brachial plexus block) between present and Paqueron study make it difficult to directly compare the results. However, we believe that *marked differences in neural architecture and size of surrounding adipose tissue compartments, which are demonstrated between proximal and distal parts of the brachial plexus, are the main reasons contributing to the discrepancies of characteristics of sensory blockade between present and Paqueron study.* The nonneural tissue (stroma and connective tissue) inside and outside the BP increased from proximal to distal, being significant between interscalene/supraclavicular and midinfraclavicular/subcoracoid regions *(6)*. In proximal regions (interscalene, supraclavicular*),* the BP *is surrounded with less fat and stroma within and out of its epineurium than in distal regions (midinfraclavicular, subcoracoid)* which certanly make differences in pharmacokinetics of LA between these two regions.

In conclusion, we believe this finding is of importance for clinicians since elderly patients are frequent in our daily practice, especially in one-day surgery. We should be alert to their increased sensitivity to elderly on local anesthetic agents and should adjust doses of LA agents in order to avoid prolonged sensory blockade in peripheral nerve blocks that can delay discharge from hospital.

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