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Original articles

The effects of gender and age on motor unit number estimation in a normal population

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Abstract

Motor unit number estimation (MUNE), is a method developed to determine the numbers of motor axons to the best possible quantity. In this study, we aimed to test the MUNE in different age groups in the normal population. This study was done on healthy volunteers who had not neither peripheral nerve nor systemic/ metabolic disease, and had a normal neurological examination. All had normal median and ulnar nerve conduction velocities. One hundred and ten subjects including 58 males and 52 females at a mean age of 38.9 ± 6.6 years were evaluated in 3 age groups. There were 36 volunteers in the age range of 15-30, 44 in the age range of 31-45, and 30 in the age range ≥ 46 (46-83). Manual incremental method was performed for MUNE. Studies and recordings with a stimulation of 0.1 msec in all subjects were completed. Gender did not have an effect on the scores (p = 0.472). Motor units detected by MUNE showed a relative decrease with ageing ; however this was not statistically significant.

Key words : Motor unit ; motor unit number estimation (MUNE).

Introduction

Motor units are the final common pathway of the motor system and refers to a single anterior horn cell or brain stem motor neuron, its peripheral axon (which travels in a cranial or peripheral nerve), and each of the muscle fibers innervated by that axon. The numbers of motor units are the functional motor neurons or axons innervating a muscle or group of muscles. The physiological determination of numbers of motor units is described as motor unit number estimation (MUNE) (1). MUNE provides determination of functional motor unit numbers quantitatively as the most similar to the real numbers and can be performed in various techniques.

Estimating the functional motor unit numbers in a human muscle group in vivo has been facilitated by using computer-aided MUNE techniques. The thought of estimating motor units was firstly mentioned by Mc Comas in 1967. There have been at least 10 various MUNE techniques reported up till now and each one has some advantages and disadvantages. There have not been so many studies directly quantifying the effect of age on MUNEs although these electrophysiological techniques have been available. There have been studies describing age-related decreases in MUNEs in the upper (thenar muscle group) (2, 3, 4, 5) and lesser in the lower limbs.

In this study, the aim was to determine the estimates of motor unit numbers in thenar muscle groups in different age groups of healthy subjects.

Material and methods

MATERIAL

The study was performed among age and sex matched 110 volunteers at a mean age of 38,9 ± 6.6 years (the age range of 17-83 years). Fifty eight subjects were males, 52 of them were females. The mean age of males was 37.7 ± 12.7 years (the age range of 18-75 years), and of females was 40.4 ± 13.5 years (the age range of 17-83 years) (p = 0.928). Subjects were evaluated in 3 age groups. There were 36 volunteers in the age range of 15-30, 44 in the age range of 31-45 and 30 in the age range ≥ 46 (46-83). Informed consent was taken from all individuals participating in this study in accordance with our institutional guidelines.

Healthy volunteers with neither peripheral nerve disease nor any systemic/metabolic disease were included in the study. All subjects were considered to be moderately active for their respective age groups. Before the study, systemic and neurological examinations of subjects were made and if they had normal findings, motor and sensory conduction velocities in median and ulnar nerves were studied and if these were also normal, MUNE study was carried on.

METHODS

The right thenar muscles of subjects were cleaned with cotton containing alcohol. A surface

Table 1

MUNE values in total males and in total females and in different age groups separately

	Male	Mn	Female	Fn	p
≥ 30	180.8 ± 47.7	21	166.9 ± 38.2	15	0.092
31-45	155.8 ± 41.3	24	156.5 ± 47.9	20	0.888
45 <	154.3 ± 45.6	13	149.6 ± 44.2	17	0.601
Total	163.4 ± 53.3	58	158.6 ± 48.8	52	0.472

Fn : number of female subjects, Mn : number of male subjects (± SD standart deviation).

recording electrode (HUSH™ Bar Electrode) was placed over abductor pollicis brevis (APB) muscle by tape with the anode in distal position. A surface ground electrode (Ground Electrode, 10 cm length, 15 mm width, 1.5 mm female Touch-proof) was encircled at the wrist.

Optimum stimulation area was determined by tracking amplitude of M response by surface stimulating electrode of which anode was proximally and it was fixed in the most prominent localization by Velcro strap. During the whole study, the place of stimulating and recording electrodes was not changed ; if a change was needed, all of the procedure was repeated.

In our study, manual incremental method was used for MUNE. In this reference method, the stimulus current delivered to the motor nerve is increased very slowly manually starting from a little above the stimulus threshold. The method is based on the 'all or none' characteristic of the activation of peripheral motor axons with electrical stimulation. The least area (or amplitude) added on CMAP (and could be repeated) is supposed to represent one motor unit. After 10 sample potentials are elicited, median area of these 10 motor units is calculated. MUNE is calculated by dividing maximum CMAP area to median value.

In this study, after electrodes were placed, intensity control switch of stimulator unit (with stable current/with variable intensity) was slowly increased from 0.0 mA and when M response with maximum amplitude was elicited, increasing the stimulus intensity was stopped.

By standard performation of apparatus in MUNE mode, current intensity decreased to minimum values automatically (generally it decreases to values like as 1/10 of maximum intensity, automatically) and was increased again slowly from this value manually. When reached an intensity a little above stimulation threshold with minimum increase, elicited M response was recorded. The difference in amplitude of M response was seen in the left (by apparatus automatically), also the amount of difference and the position of difference (negative or positive) in the right of screen. Observing this difference, second response was also recorded and this procedure was repeated 10 times. At the end of this procedure, estimates of fibers were seen as numbers on the screen. This was the result of division of the average value of area of M response occurring with each various stimulations, to the area of maximum M response.

The whole study was performed with a Dantec Keypoint apparatus and incremental MUNE mode of apparatus was used prepared commercial and loaded to the apparatus. For statistical analysis, SPSS 12 program was used.

Results

Median MUNE of right thenar muscle innervated by median nerve with duration of 0.1 msec and a standard stimulation condition was found 161 ± 50.6. Similar MUNE values were found but high standard deviation was an important finding.

MUNE of males and females were 163.4 ± 53.3 and 158.6 ± 47.8 respectively. Statistical evaluation showed that gender had no effect on MUNE (p = 0.472, Mann-Whitney test) (Table 1).

In 15-30, 30-45 and ≥ 45 age groups MUNEs were 171.3 ± 44.9, 156.1 ± 43.9, 151.6 ± 44.1 respectively. In different age groups the value was found to decrease relatively by ageing (p = 0.16, Kruskal-Wallis test). These data indicated a relative, not statistically significant, but an absolute fiber decrease with ageing (Table 2).

Discussion

Today there have been many available MUNE techniques. The base of all of them is to evaluate the feature of motor units able to represent all motor units and provides determination of functional motor unit numbers quantitatively as the most similar to the real numbers. All techniques have been developed on the base of manual incremental method introduced by McComas in 1971 (6).

The aim of MUNE study is to estimate the number of fibers in a nerve the most correctly and as the most similar to the real numbers. Certainly, the most accurate way of this is to estimate fibers histologically. The correlation between histological and electrophysiological studies has not performed so much (7, 8). But generally, according to the criteria such as test reliability, the necessary period for completing study, easiness, obtaining data parallel

Table 2

MUNE values in between age groups

	Male	p	Female	p	Total (F + M)	p
≥ 30	180.8 ± 47.7 (± SD)		166.9 ± 38.2		171.3 ± 44.9	
31-45	155.8 ± 41.3	0.38	156.5 ± 47.9	0.57	156.1 ± 43.9	0.16
45 <	154.3 ± 45.6		149.6 ± 44.2		151.6 ± 44.1	

F = female, M = male (± SD standart deviation).

to disease and sufficiency in determining progression of disease, it has been concluded that none of these various methods has not been superior to each others (9).

Manual incremental method was used in this study. The investigator decided the sufficiency of stimulus intensity for the following step and enough difference between miniature motor units by himself. Our results revealing quite similar values in standard conditions showed that the method was reliable. These findings support the hypothesis that this method could be used in clinical practice with an alternation factor. Daube (10) also accepted deviations up to 10 % even by statistical method which has been developed more.

In our study, average motor unit numbers recorded from APB muscle obtained from inside of wrist was found about 161. This value is quite consistent when compared with other studies in which the values were found between 100 and 300 (6, 11). In our study, MUNE dispersion also showed variation mostly between 100 and 250.

According to our literature knowledge, we did not find a study investigating the association between gender and MUNE scores. Our study showed that gender has no effect on MUNE scores ($p = 0.472$). However, to get more accurate data on this subject, more advanced studies should be needed to investigate the relation between hormonal parameters and MUNE.

It is known that loss of functional motor units occurs in elderly ages. The motor unit loss is gradual over the first 6 decades but accelerates thereafter (5, 12, 13, 14, 15, 16). Campbell *et al.* (14) suggested that this process started after the age of 60 years and was confirmed for the EDB (13) and the biceps brachii (17) muscles respectively (18, 19). Various investigators especially Brown found similiar results in their studies (18, 20). Loss of motor units starting at about 60 years was also confirmed by anatomical counting of motor units in lumbosacral enlargement (21). Evoked motor unit potential amplitude estimates showed that the sprouting process of surviving motor neurons in the elderly spinal cord is not as effective as in younger population with comparable muscle denervation but they are still capable of undertaking collateral reinnervation (16). In these studies, the rate of decrease in motor unit numbers was determined as approximately 3% in each year during the seventh decade (14, 19). In a study made by multiple point stimulation, older subjects (33 in 63-81 age range) were found to have about half the number of thenar motor units as compared to younger subjects (37 in 20-40 age range) (3). In our study, when age ranges were compared, although not significant, a relative decrease by ageing was observed. The difference which was not significant could be a result of insufficient numbers of subjects above 60 years of age (11 subjects).

MUNE studies have been started to take place in electroneuromyography practice and became a research subject for innumerable clinical studies. This technique has been also accepted as a method to determine the prognosis in a great deal of neurological diseases especially motor neuron disease and to follow-up those patients. By using these techniques in daily practice, the effect of pharmacological agents on the disease process can be investigated. From this point of view, every electrophysiological laboratory should establish their data on their normal population by taking into consideration ethnic and genetic features for the future researches.

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