EFFECTS OF DEMOGRAPHIC AND ANTHROPOMETRIC MEASURES ON NEUROGRAPHIC PARAMETERS OF THE ULNAR NERVE

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Background

Associations among neurographic parameters and temperature, age, gender and anthropometric factors were documented [1-11]. The effects of multiple demographic and anthropometric factors on the ulnar nerve were not systematically performed and almost all the studies used statistical univariate analyses.

Aim of the study

Our purpose was to examine the relations of age, height, gender, BMI, waist-to-hip ratio (WHR), arm and elbow measures and occupation on motor and sensory neurographic parameters of the ulnar nerve in a sample of "symptom-free" subjects belonging to a database designed for another aim.

Electrophysiological and statistical methods

We calculated: **MCV** of forearm and across-elbow segments and **CMAP** amplitudes, **SNAP** and **SCV** (IV and V digit-wrist tract) of the ulnar nerve, SNAP and SCV of the dorsal ulnar cutaneous nerve (DUC). We measured: height, weight, waist and hip circumference, width of elbow and cubital groove, and length of the upper limb. Occupation was classified in "blue collar" and "no-blue collar" according to the job titles of ISCO-2008 (for details see the methods of poster no.498). We estimated the effects of the demographic and anthropometric measures on the neurographic parameters of the ulnar nerve by univariate analysis with Spearman's correlation coefficient and by multivariate analysis with linear regression analysis. The goodness of fit of the models was checked by the determination of coefficient R^2. Based on the multivariate analyses neurographic values were expressed with derived regression equations.

Results

Univariate analysis

Age inversely correlated with all motor and sensory neurographic values (r between -0.29 and -0.55), only DML was not related to age.

Height and arm length are positively related with DML (r=0.29 and 0.24, respectively) and inversely with MCV, U4 and U5 SNAP (r between –0.19 and –0.29).

BMI showed an inverse correlation with MCV, CMAP, U4 and U5 SNAP amplitudes (r between -0.24 and -0.41).

WHR inversely correlated with all motor and sensory neurographic values (r between -0.24 and -0.5) except for CMAP amplitude; and directly correlated with DML (r=0.18).

Elbow dimensions and **occupation** were not related with any neurographic values.

There were differences between **genders.** Females were less tall, have lower BMI, WHR and DML, faster MCV, higher U4, U5 and DUC SNAP amplitudes than males.

Multivariate analysis

Because several variables were interrelated and some variables were proxy of others (for example arm length was a proxy of height, WHR a proxy of height and BMI), we performed multivariate linear regressions (see table) including as covariates age, height, BMI and gender.

Age entered in all models; height in the models of MCV and DML; BMI in the model of CMAP; BMI and gender in the models of U4 and U5 SNAP amplitudes; and age and gender in the model of DUC SNAP (see table).

Based on the multivariate analyses neurographic values were expressed with regression equation (see table).

Subjects

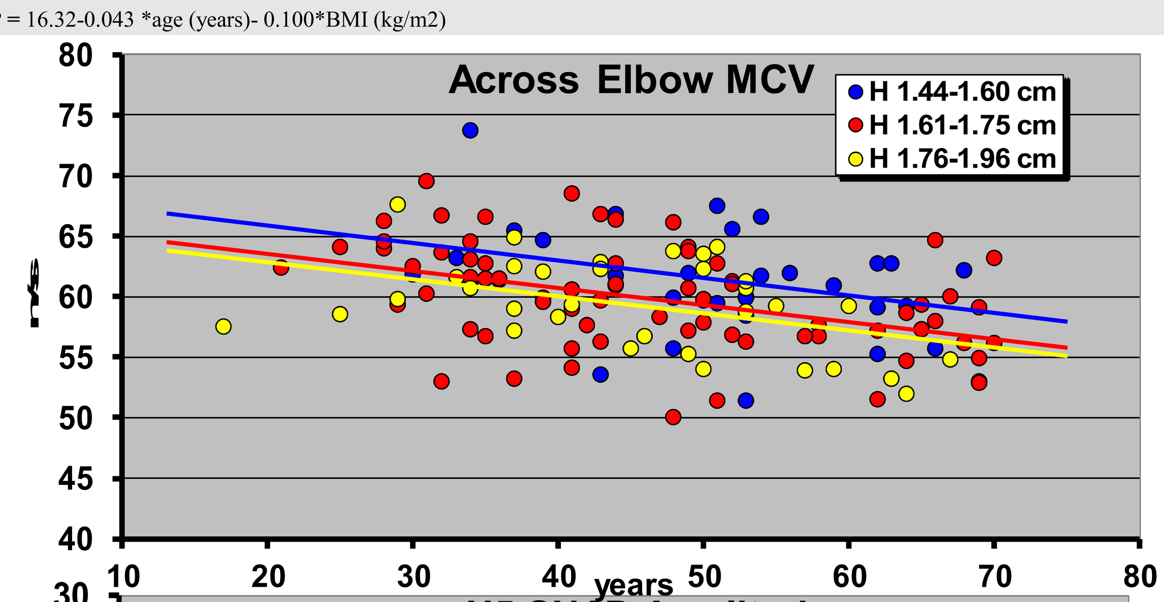
We prospectively enrolled 137 consecutive subjects (mean age 47.3 years, 48.9% females) among all patients referred to 3 outpatient EMG labs to perform an electrodiagnosting testing of the upper limbs from June 2014 to April 2015. They had neither a disease affecting peripheral nervous or muscular systems nor symptoms or neurological examination suggestive of peripheral nerve anomalies. Subjects with age <14 and >70 were excluded.

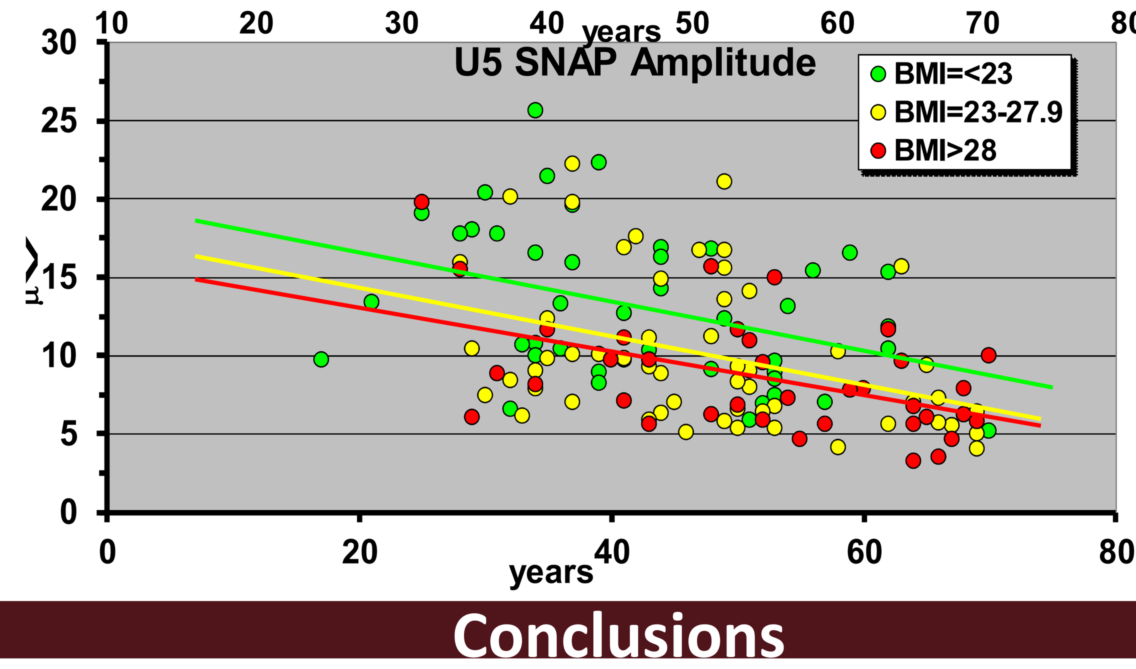
Neurographic parameters	Estimate	SE	p-value	R2
MCV of forearm				0.189
-Intercept	83.6	6.13	<0.0001	
-Age (years)	-0.139	0.027	<0.0001	
-Height (m)	-10.1	3.42	0.004	
MCV across elbow				0.244
-Intercept	103.2	8.53	<0.0001	
-Age (years)	-0.202	0.037	<0.0001	
-Height (m)	-22.2	4.76	<0.0001	
DML				0.084
-Intercept	1.47	0.369	<0.0001	
-Height (m)	0.768	0.218	0.001	
CMAP				0.115
-Intercept	16.32	1.19	<0.0001	
-Age (years)	-0.043	0.015	0.007	
-BMI (Kg/m²)	-0.100	0.046	0.030	
SCV U4				0.192
-Intercept	67.77	1.51	<0.0001	
-Age (years)	-0.170	0.031	<0.0001	
SNAP U4				0.301
-Intercept	17.86	1.89	<0.0001	
-Age (years)	-0.115	0.025	<0.0001	
-Gender	-2.21	0.59	<0.0001	
-BMI (kg/m²)	-0.158	0.071	0.029	
SCV U5				0.224
-Intercept	65.53	1.40	<0.0001	
-Age (years)	-0.178	0.029	<0.0001	
SNAP U5				0.355
-Intercept	25.14	2.17	<0.0001	
-Age (years)	-0.148	0.028	<0.0001	
-Gender	-2.897	0.677	<0.0001	
-BMI (kg/m²)	-0.238	0.084	0.005	
SCV DUC				0.212
-Intercept	67.01	2.758	<0.0001	
-Age (years)	-0.218	0.057	<0.0001	
SNAP DUC				0.363
-Intercept	40.61	4.0	<0.0001	
-Age	-0.347	0.079	<0.0001	
-Gender	-7.01	2.19	0.002	

TABLE 1

Regression equations
MCV of forearm = 83.6-0.139*age (years)-10.1*height (m)
MCV across elbow =103.2-0.202*age (years)- 22.2*height (m)
DML = 1.47 +0.768 *height (m)
SCV U4 = 67.77-0.170 *age (years)
SCV U5 = 65.53 -0.178*age (years)
SCV DUC = 67.01 -0.218*age (years)
SNAP U4 = 17.86 -0.115 *age (years) -2.21 (if male)*gender-0.158*BMI (kg/m2)
SNAP U5 = 25.14 -0.148*age (years) – 2897 (if male)*gender-0.238*BMI (kg/m2)
SNAP DUC = 40.61 -0.347*age (years) -7 .02 (if male)*gender
CMAP = 16.32-0.043 *age (years)- 0.100*BMI (kg/m2)

TABLE 2





Discussion

NCV parameters are significantly related to a subject's age, height, gender and BMI. The influence of these variables is different according to different neurographic parameters taken into account [1-11]. Many studies were performed using univariate analysis [1,3,5,6,7] and few were focused on the ulnar nerve [8,9,10]. We recruited a large sample of "control" and we used univariate and multivariate analyses to test the relations among ulnar nerve neurographic parameters and demographic and anthropometric factors, after skin temperature was controlled (>32°C).

AGE

We confirmed the well-known statement that SCV, MCV, SNAP and CMAP amplitudes of the ulnar nerve decreases with increased age as observed in all the other nerves [1,2,3,6,7,10]. The decrease of nerve function with age is supported by anatomical evidence of decreased number of nerve fibers, reduction in fiber diameter (and consequently myelin thickness and internode distance) and changes in the electrical properties of fiber membrane [3].

There is also progressive decreased of SNAP and CMAP amplitudes with age due to physiological loss of primary sensory and motor neurons and reduction of axon numbers. Aging may have stronger contribution to lower SNAP and CMAP amplitudes particularly in the nerves in sites of common entrapment than in the nerves without entrapment sites [1]. On the contrary some authors showed that the relation between age and NCV is nonlinear. Based on modeling methods to develop quadratic equations for NCV, subjects until 60 years do not have to be corrected because the effect of age were minimal; after 60 years NCVs are slower and must be corrected [6].

HEIGHT

We found inverse linear relationship between MCV and DML of the ulnar nerve and height but not with SCV as reported in other studies [6,7,9,10]. The difference may be the result of different sites of the measurement of NCV: for MCV in the arm and forearm segments and for SCV in the wrist-finger tracts. Other factors, as hand and finger dimension, may be more important than height for distal SCV. The inverse relation of NCV and height is classically explained with "tapering" (reduction of axon diameter in the distal segment of the nerve). But an anatomical research demonstrated that there is no (or only little) tapering of nerve fibers, which means that the nerve fibers have the same (or nearly the same) diameter both close to and distant from the cell soma [12]. Some studies demonstrated a negative correlation with NCV of the ulnar motor and the left median sensory nerves and height [9]. On the contrary, other researches did not find any correlation between height and NCV of the ulnar nerve [10,11]. It is not easy to explain why DML was positively related only to height. DML includes the time required for the propagation through the myelinated terminal part of the nerve, the synaptic time of neuromuscular junction and conduction time through muscle tissue (residual latency). Only distal part of the nerve may be related to the height.Previous studies showed that height was positively correlated with the latencies of the sural, peroneal, tibial, and median nerves similarly to our results [6].

BMI

We observed an inverse relation between BMI and CMAP, U4 and U5 SNAP amplitudes, as observed in other studies, but not with DUC SNAP. The negative relation between SNAP and CMAP amplitudes and BMI might be due to the finger and wrist size. The finger circumference alters SNAP amplitude and this may also explain gender-related difference in SNAP amplitude [2,8]. Obese subjects have a thicker subcutaneous layer (fingers and wrist), resulting in small SNAP and CMAP. But this likely does not occur in the dorsum of the hand because DUC SNAP is not related to BMI. DML, MCV and SCV were not correlated with BMI indicating that in the clinical setting the fastest fibers conduct equally quickly in thin and heavy individuals.

GENDER

We found that many differences in neurographic parameters between males and females disappeared when height and age were added in the models, however the gender remained in the models of CMAP and SNAP U4 and U5 amplitudes. We found values of SNAP amplitude much lower in males than in females otherwise described in the literature about the nerves of the lower limbs [3].

OCCUPATION

There were no differences between blue and no-blue collars.

Conclusions

Our original findings showed the absence of relationship between elbow anthropometry, WHR and ulnar neurography. We hypothesized that VCM across elbow may be related to some job tasks or elbow posture and activities regardless to job title and to some comorbidity factors rather than elbow and body anthropometric and demographic factors. This will be object of future elaboration of our database.

"Reference" neurographic values of the ulnar nerve should be adjusted for demographic and body anthropometric factors. Multiple regression equations could optimize the clinical practice and improve the diagnostic sensitivity of neurographic measures in the diagnosis of ulnar neuropathies.

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