STUDY OF SENSORY NERVE CONDUCTION OF MEDIAN AND ULNAR NERVES IN THE UPPER LIMBS: EFFECT OF AGE, GENDER AND BMI.

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ABSTRACT:

INTRODUCTION: Nerve conduction studies play an important role in clinical practice and research. They are a standard procedure for evaluation of peripheral neuropathy. Subject data is typically compared with the normative data to interpret study results. Temperature control and standardized technique along with consideration for age, gender, height and instrumentation is imperative for appropriate interpretation of electro diagnostic studies.

OBJECTIVE: In the present study the effects of age, gender and BMI on sensory conduction velocity and sensory amplitude of the compound nerve action potential of median and ulnar nerves of adults were prospectively studied.

METHODS: The present study included 180 normal subjects who were divided in three groups according to their age. An additional 20 subjects with a BMI more than 30 kg/m^2 from the age group 18 – 30 years were taken and were labeled as obese group. Parameters were recorded using NEUROCARE ^{TM} 2000 which is a computerized EMG/NCV/EP Equipment.

RESULTS: Conduction velocity and amplitude of the compound action potential were found to decrease with age. No effect of gender was seen on the conduction velocity, but a difference in amplitude was obtained between males and females. Amplitude was found to be greater in females as compared to males. Increasing BMI also showed no effect on conduction velocity but decreased the amplitude.

KEY WORDS: Sensory Conduction velocity Body Mass Index Age Gender Amplitude

INTRODUCTION

Determination of peripheral motor and sensory nerve conduction velocity has come to play a prominent role in clinical diagnosis. Increased use of nerve conduction studies in clinical practice and research and attention to quality in health care has heightened interest in the reliability of results. For this reason proper reference values are critical for valid interpretation. The use of conduction studies as a diagnostic procedure in neurology requires a knowledge of the range of values encountered in healthy individuals.

It was at the first Congress of Electromyography in 1961 that Lambert summarized the clinical value and importance of stimulating peripheral nerves and recording the evoked muscle action potentials (1). Most of these studies although appropriate for their time, did not maintain room temperature and some did not account for potential differences in results, depending on the demographic characteristics that could potentially affect the values e.g. age, gender, height etc

In the present study the effects of age, gender and BMI (Body Mass Index) on sensory conduction velocity and amplitude in median and ulnar nerves of adults were prospectively studied. The effect of age and gender in adult nerve conduction studies are of importance to the clinical neurophysiologist in establishing tighter control data. An increase in obesity prevalence has been observed globally. Obesity poses as a risk factor for many diseases eg hypertension, ischaemic heart disease, stroke, carpal tunnel syndrome etc. Thus it is very important to study the effect of increasing BMI and fat percentages on nerve conduction parameters.

Recently there has been increased attention for the development of normative data against which test results can be compared. This study provides normative age and gender matched electro diagnostic data for the median and ulnar nerves which can be used as reference values.

MATERIALS AND METHODS

The present study included 180 normal subjects who were divided in three groups according to their age. The three age groups are Group I (18-30 years), Group II (31-45 years) and Group III (46-60 years). Out of the 60 subjects in each group, 30 were males and 30 females. An additional 20 obese subjects (8 males; 12 females) with a BMI more than 30 kg/m^2 from the age group 18–30 years were taken and compared with 20 people (13 males;7 females) of normal BMI selected randomly from Group I. Study was performed in accordance with ethical standards of the institute.

Subjects were called in the morning after light breakfast. They were made to sit for half an hour in an air-conditioned room with temperature being maintained between 21 - 23 degree Centigrade (2). All the measurements were taken with the subject sitting up comfortably on a wooden stool. The procedure was fully explained to the subject and written informed consent was taken. A detail history with preliminary details was taken for each subject. BMI was calculated by the formula weight/height square expressed as kg/sq.m . All recordings were taken from the dominant hand.

Exclusion criteria included any metabolic disorder, fracture, deformity, radiculopathy, nerve compression, neurological disorder, intake of certain drugs, any addictions etc. The exclusion criterion was done with the help of detailed history and examination.

In the present study sensory nerve conduction velocity across the median and ulnar nerve is studied using NEUROCARE ™ 2000 which is a computerized EMG/NCV/EP Equipment. Sensory nerve conduction velocity is measured by stimulating at a single stimulation site. The stimulating electrodes were placed with anode 2-3 centimeters proximal to cathode. Stimulation was applied over the median and ulnar nerve at a point 14 cm proximal to the proximal interphalangeal joint (PIP) joint of the index and little finger. A supramaximal strength of stimulus was used. The compound nerve action potential was recorded using a pair of ring electrodes. The ground electrode was placed on the dorsum of the hand between the stimulating and recording electrodes.

For Sensory Studies: Sensitivity: 10–20 μv/mm, low frequency filter: 5–10 Hz, high frequency filter: 2–3 KHz, sweep speed: 1–2 ms/mm.

Results were expressed as mean±S.D. Comparisons for effect of age on nerve conduction velocity and amplitude were made between groups by ANOVA test followed by a post test (Tukey Kramer). To study the effect of gender and BMI on nerve conduction velocity and amplitude Students unpaired't' test is used. P-value, less than 0.05, was considered as significant.

RESULT

Table I gives the anthropometric characteristics namely height, body weight and BMI of these volunteers. Comparisions between the groups was done using one way ANOVA.

Table II shows the comparison of age with conduction velocity and amplitude.

There is no significant difference in conduction velocity and amplitude between Group I and II, and between Group II and III. But there is a significant decrease in these parameters when compared between Group I and Group III. Comparisions were done using one way ANOVA followed by Tukey Kramer post test.

In Table III the effect of gender was studied on conduction velocity and amplitude. The conduction was found to be faster in females as compared to males but the difference was not significant. Females were found to have a statistically significant difference in amplitude as compared to males of the same age group. Analysis was done using students unpaired t test. Table IV gives the comparison of nerve conduction and amplitude between normal and obese individuals. No difference was found in the conduction velocity between the two groups, but a significant decrease in amplitude was observed in obese group as compared to normal.

Table I: Anthropometric parameters of subjects of different age groups of both the genders

PARAMETERS	GROUP I	GROUP II	GROUP III	P Value
MALES				
Height (cm)	165.4±9.3	162.9±8.95	164.1±10.05	0.59
Weight (kg)	64.43±10.59	66.73±10.09	61.26±7.29	0.08
BMI (Kg/m2)	23.47±3.08	24.66± 2.22	23.12±2.15	0.05
FEMALES				
Height (cm)	160.03±9.46	162.5±10.14	160.57±9.5	0.58
Weight (kg)	59.03±10.19	63.13±10.01	62.13±8.9	0.24
BMI (Kg/m2)	23.02±2.86	23.57±2.38	23.87±2.44	0.43

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Statistical analysis was done by one-way ANOVA. Data presented are mean±SD

TABLE II: Comparison of Nerve Conduction Velocity and Amplitude in different age groups

		GROUP I	GROUP II	GROUP III	P value
Conduction velocity	**Median**	64.06±1.58	63.87±1.09 NS*	63.38±1.33 * NS#	0.0186*
	Ulnar	63.85±2.54	63.295±1.2 NS*	62.57±1.73 *** NS#	0.001**
Amplitude	**Median**	51.83±1.258	51.17±1.489 NS*	50.47±2.13 *** NS#	0.0001 ***
	Ulnar	52.59±1.429	52.19±1.368 NS*	51.79±1.56 ** NS#	0.013 *

Comparison	P Value	Result
Group I Vs II	> 0.05	Not Significant
Group I Vs III	< 0.05	Significant
Group II Vs III	> 0.05	Not Significant

Data presented are mean±SD. Statistical analysis was done by one-way ANOVA and post-hoc by Tukey-Kramer test.
* P< 0.05; ** P < 0.01; *** P < 0.001; NS* - not significant.

TABLE III: Comparison of Nerve Conduction Velocity and Amplitude between Males and Females

CONDUCTION VELOCITY				AMPLITUDE			
MEDIAN	**MALE**	**FEMALE**	**P value**	**MEDIAN**	**MALE**	**FEMALE**	**P value**
Group I	64.17+0.89	64.52+1.29	0.23	**Group I**	51.4+1.137	52.25+1.23	0.007 *
Group II	63.78+1.14	63.96+1.06	0.54	**Group II**	50.69+1.17	51.64+1.63	0.01 *
Group III	63.24+1.32	63.5+1.35	0.449	**Group III**	49.83+2.02	51.12+2.08	0.01 *
ULNAR	**MALE**	**FEMALE**	**P value**	**ULNAR**	**MALE**	**FEMALE**	**P value**
Group I	63.54+2.56	64.17+2.53	0.344	**Group I**	52.4+1.48	53.2+1.27	0.027 *
Group II	63.09+1.02	63.49+0.83	0.087	**Group II**	51.8+1.369	52.58+1.27	0.025 *
Group III	62.36+1.73	62.78+1.72	0.349	**Group III**	51.4+1.66	52.2+1.36	0.048 *

Results are expressed as mean±S.D using Students unpaired \`t\` test. * P< 0.05

Table IV: Comparison of conduction velocity and amplitude between normal & obese individuals

PARAMETERS	NERVES	NORMAL	OBESE	P value
Conduction velocity	**Median**	63.76+1.74	63.3+1.1	0.32
	Ulnar	64.54+2.88	63.54+1.78	0.19
Amplitude	**Median**	52.87+1.78	51.23+2.08	0.01*
	Ulnar	52.93+1.27	51.05+1.89	0.0007*

Results are expressed as mean±S.D using Students unpaired \`t\` test. * P< 0.05

DISCUSSION

Nerve conduction study is based on the simple principle of applying an electrical stimulus at a point on the nerve and recording the signal at another point on the innervated muscle. The complexity lies in its clinical application and interpretation of the results.

In the present study the conduction velocity ranged from 60 to 68m/sec for the median nerve and from 57 to 70 m/sec for the ulnar nerve respectively.

In our study we found that the nerve conduction velocity for both median and ulnar nerves declined with age (Table II).

The results are consistent with most of the studies in the past. Studies in accordance with present study are as follows. Richard F. Mayer (1963) observed that after the age of 50 years there was a decrease in nerve conduction velocity, which was more apparent in upper than lower extremities and was more prominent distally (3). Dana et al (1992) studied effects of age, sex and anthropometric factors on nerve conduction measures. They found that age was significantly associated with sensory amplitudes and all conduction and latency measurements (4). Henry et al (2004) did a prospective study for sensory nerve conduction 5.4 years apart. They showed that change occurred at a greater rate in median than in ulnar sensory nerve parameters (5). In the study done by Berenice et al (2004) among 92 employees at Santa Casa, they reported a reduction in the velocity of motor and sensory nerve conduction with age (6).

Studies which disagree with the above-mentioned researchers and our observations, have been done by Kauchtschischwili et al in the year 1962 (1) and by Michael Thomas & Malik (2001). They found age to be negatively correlated with nerve conduction.(7)

It is seen from our study that there occurs a decline in nerve conduction velocity with age. The causes for such a decline can be attributed to loss of neurons, axonal degeneration, demyelination, loss of myelinated and unmyelinated fibres and changes in membrane permeability. Also, with age the regeneration capacity of the nerves after injury decreases. A progressive reduction of nerve blood flow occurs with aging thus decreasing the supply of nutrients (oxygen, glucose) to the aged neurons which also may affect the velocity.

The amplitude of sensory nerve action potential suggests the density of nerve fibres. The amplitude is variable not only in different normal individuals but also in the same individual on two sides. In our study we found that there is a decline in amplitude with increasing age (Table II).

The studies which agree with our studies are that of Peter Kenneth Taylor who found that from the fifth decade onwards, sensory and motor nerve conduction velocity and amplitude decline at an increasing rate with increasing sensory duration (8). Also Ralph M Buschbacher in the year 1999 studied mixed nerve conduction in median and ulnar nerves and found that increase in age correlated with a decrease in amplitude (9). Similar studies done by Michael Thomas & Malik (8) and Berenice et al (6) reported that age was strongly correlated inversely with the amplitudes of sensory and motor responses.

From the above studies it can be concluded that the amplitude of the sensory nerve action potential decreases with age and this decrease is significant after the age of 45 - 50 years. The possible mechanisms for this decline in amplitude with aging could be due to reduction of number of axons, loss of functioning motor units, segmental demyelination and decrease in axonal transport.

In the present study the effect of gender on conduction velocity is also studied. Findings show that females conduct faster than males but this difference is statistically not significant (Table III).

The finding of the present study is consistent with that of previous researchers like Nielsen, who in 1973 studied the median nerve in men and women and found no difference in relation to gender (10). According to the study by Rasoul Soudmand, Charles Ward & Thomas Swift (1982), nerve conduction velocity was not related to sex when height was removed (11).

In opposition to above findings, in the work done by some other authors, it is notable that women conducted faster than men and the difference was statistically significant.

LaFratta & Smith (1964) found conduction to be greater in females then males in the ulnar nerve (12).A study by Hennessey and others (1992) confirmed that women had significantly faster ulnar sensory nerve conduction velocity and shorter ulnar distal motor latency (13). Lawrence, Doborah, Patricia Wilfred, & Walter (1993) analyzed that women had significantly faster conduction velocities than men for all nerves except median motor (14).

On studying the effect of gender on amplitude in sensory part of these nerves, females were found to have a greater amplitude as compared to males of the same age group (Table III).

Lawrence, Doborah, Patricia Wilfred & Walter (1993) analyzed median, ulnar, peroneal and sural nerves. It was observed that three of four sensory amplitudes were larger in women (median, ulnar and sural) (14). Hennessey & others (1992) observed that women, in comparison to men, have significantly larger distal amplitudes for median, ulnar and radial nerves (13). Even the study done by Bolton is in accordance with our results (15). As opposed to this study done by Buschbacher RM failed to show any significant difference in amplitudes in milieu with gender (9).

The reason that women have larger sensory nerve action potential amplitudes is probably a reflection of thinner fingers and less tissue between the nerve and the surface recording electrodes. Since amplitude decreases as the distance between nerve and electrode increases our results were in the expected direction. Further studies correlating finger circumference with amplitude are required to validate our diagnosis.

Conduction velocity and amplitude of normal individuals were compared with obese. Conduction velocity did not change, but a decrease in amplitude was observed as the BMI increased (Table IV).

Ralph Buschbacher in 1998 found no correlation between nerve conduction studies and BMI, whereas the sensory and mixed nerve amplitudes decreased significantly with increasing BMI (16).

Study done by Letz & Gerr (1994) found nerve conduction of the median nerve to decrease with increase in weight, whereas the conduction velocity of ulnar, peroneal and sural nerves tends to improve among subjects who were obese (17).

The findings of our study can be attributed to a thicker subcutaneous layer in obese individuals. As most routine nerve conduction studies employ percutaneous stimulation and recording techniques, a thicker layer of subcutaneous fat might interfere with the recording and detection of signals hence there is a decrease in the amplitude.

CONCLUSION

In conclusion our results, provides one with normal reference values matched for most of the physiological factors i.e age, gender, temperature, limb dominance. The results become important in neurology for comparisons of patient data. It is also seen from the present study that age is an important cofounder responsible for decrease in conduction velocity and amplitude of the sensory nerve action potential. There was no significant difference in conduction velocity in context with gender. However sensory amplitudes were found to be greater in females than males of the same age group. Further research correlating height, limb lengths and finger circumference with gender is required in this field. The relationship of obesity with these two nerve conduction parameters was studied. It was found that conduction velocity did not alter with increasing BMI, but a decline in amplitude of the sensory nerve action potential was observed in obese individuals as compared to subjects with normal BMI. These findings need to be further confirmed by taking a larger sample size and also by correlating the percentage of body fat with conduction velocity and amplitude.

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