Nerve Conduction study in healthy individuals a preliminary age based study

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ABSTRACT

Background

Nerve conduction study assesses peripheral nerve functions and has clinical implication.

Objectives

To study the effect of age on nerve conduction study variables in healthy adults.

Methods

Cross sectional study was done from Jan 2006 to Dec 2006 in department of Physiology, BP Koirala Institute of Health Sciences, Dharan, Nepal. The study was done in 34 (younger, n= 18, 17 to 29 years; older, n= 16, 30 to 57 years) consenting healthy adults of either sex. The compound muscle action potential and sensory nerve action potential were recorded using standard technique. Due to the non-normal distribution of data, the effect of age on nerve conduction study variables was analyzed using Mann Whitney U test.

Results

Younger vs. older individuals: older had lower Compound Muscle action potential amplitude (mV) in all motor nerves except radial and left ulnar nerves. Compound Muscle action potential duration (ms) was shorter in older ($p<0.05$) in ulnar, tibial, right median and left common peroneal motor nerves than the younger: right median (6.92±1.3 vs. 8.5±1.88), right ulnar (7.09±1.54vs. 8.2±1.31), left ulnar (10.56±1.44 vs. 12.06±1.5), right tibial (6.28±0.81vs. 7.28±1.12), and left tibial (9.58±1.52vs.10.78±1.71). Sensory nerve actional potential amplitude (µV) was smaller in older as compared to younger: right median (19.01±7.83 vs. 26.97±10.63), right ulnar (10.9±3.44 vs.16.09±5.85) and right radial (14.31±4.34 vs.19.72±6.47). SNAP duration (ms) was longer in older: right ulnar (1.34±0.17 vs.1.26± 0.18), left ulnar (1.46±0.14 vs. 1.29±0.26), and left median (1.11± 0.14 vs. 1± 0.14).

Conclusions

Age has definite effects on amplitude and duration of motor and sensory nerves. Different nerves have different timing of aging. Without adjustment for age, the sensitivity and specificity of nerve conduction study will decrease whenusing the same reference data in patients with different age.

Key Words

age, compound muscle action potential, nerve conduction study, sensory nerve action potential

INTRODUCTION

e electro-diagnostic assessment of peripheral nerves includes two major components: nerve conduction (NCS) and needle electromyography (EMG) studies. NCS assesses peripheral motor and sensory functions by the motor NCS requiring stimulation of a nerve while recording from a muscle innervated by that nerve, whereas sensory NCS by stimulating a mixed nerve while recording from a mixed or cutaneous nerve.[1, 2] ese studies have been used clinically for many years to identify the location of peripheral nerve disease in single nerves and along the length of nerves and to di erentiate these disorders from diseases of muscle or neuromuscular junction[3]. Routine NCS includes assessment of compound muscle action potential (CMAP) and sensory nerve action potentials (SNAP) of accessible peripheral nerves in upper and lower limbs including median, ulnar, radial, common peroneal, tibial and sural nerves. Commonly measured parameters of CMAP include latency, amplitude, duration, conduction velocity and late response, e.g.

F-waves. Similarly for SNAP, latency, amplitude, duration and conduction velocity are routinely measured. ese parameters are known to vary with demographic pro le, anthropometric measurements of the population studied and laboratory conditions of the test.[1, 2, 3] So, the aim of our research was to study the e ect of age on NCS parameters in healthy adults.

METHODS

is cross sectional study was done on in Clinical Neurophysiology Lab of Department of Physiology, BPKIHS using Digital Nihon Kohden machine (NM-420S, H636, Japan). 34 healthy adult volunteers of either sex (younger, n= 18, 17 to 29 years; older, n= 16, 30 to 57 years old) were included in the study. History or neurological examination nding suggestive of any medical illness or drugs associated with the NMJ disorders; heavy workers (based on the nicotine dependence questionnaire) and drinkers (based on alcohol use disorder identi cation test) were excluded.

Informed wri en consent was taken from the subjects. All the required set up was checked before starting the test and room temperature was maintained at the thermo neutral zone i.e. 26±2°C. Further, subjects were made comfortable with the laboratory set up and conditions so as to make them completely relaxed.

Recording procedure[1, 2]

Motor NCS variables e stimulator with water soaked felt tips were plac1 al and tibial nerves were recorded.

Sensory NCS variables Ring and surface stimulating electrodes were used for orthodromic and antidromic (sural nerve) stimulation respectively (see table 2). Stimulating or recording electrode was placed on a purely sensory portion of the nerve. Gain was set at 10-20 mV per division. An electrical pulse of either 100 or 200 micro seconds of duration was used. Current was slowly increased from a base line of 0 mA, usually by 3-5 mA at a time until the supramaximal stimulation of nerve was ensured. For each stimulation site, SNAP latency, duration, amplitude, and conduction velocity of median, ulnar, radial and sural nerves were recorded.

Data collected were rst entered in the Microso Excel Worksheet and then statistically analyzed using SPSS 10.0 version. Due to the non-normal distribution of data, Mann Whitney U test was applied to see the e ect of age on NCS variables. Signi cant di erence was considered at $p< 0.05$ and is indicated in appropriate places, if present in any of the parameters.

RESULTS

Effect of age on motor nerve conduction study variables

CMAP amplitudes of bilateral median, right ulnar, right tibial ($p < 0.05$), le tibial ($p < 0.01$) and bilateral common peroneal nerve ($p < 0.05$) were found to be lower in the older than the younger ones. CMAP durations were shorter in the older than the younger ones of right median, right ulnar ($p < 0.05$), le ulnar, right tibial ($p < 0.01$), le tibial, le common peroneal nerve ($p < 0.05$). CMAP latencies of the right common peroneal ($p < 0.05$) nerve were found to be smaller in older than the younger ones. F-wave latencies were longer in older than the younger ones of the le tibial nerve ($p < 0.05$). None of the parameters of bilateral radial nerve showed statistical signi cance.(table 3)

Effect of age on sensory nerve conduction study variables

e SNAP amplitudes of the bilateral median nerve, right ulnar ($p < 0.05$), and right radial ($p < 0.01$) nerves were

Table 1. Stimulation and recording sites of motor nerves

Motor nerve	Site of stimulation				Recording site
	Proximal 3	Proximal 2	Proximal 1	Distal	
Median	-	-	Antecubital fossa	Wrist	Abductor pollicisbrevis
Ulnar	Axilla	Above elbow	Below elbow	Medial wrist	Abductor digitiminimi
Radial	-	Below spiral groove: lateral midarm	Elbow	Forearm: over the ulna	Extensor indicisproprius
Common peroneal	-	Lateral popliteal fossa	Below bular head: lateral calf	Anterior ankle	Extensor digitorumbrevis
Tibial	-	-	Popliteal fossa	Medial ankle	Abductor hallucisbrevis

Table 2. Stimulation and recording sites of sensory nerves

Sensory nerve	Method of stimulation	Stimulation site	Recording site
Sural	Antidromic	Posterior-lateral calf	Posterior ankle
Median	Orthodromic	Index nger	Middle of the wrist
Ulnar	Orthodromic	Li le nger	Medial wrist
Radial	Orthodromic	umb	Distal- mid radius

found to be smaller in older than the younger ones. SNAP durations of the left median ($p < 0.01$), and bilateral ulnar ($p < 0.05$) nerves were longer in older ones. The SNAP latencies ($p < 0.05$) of the left ulnar sensory nerve were longer in older than the younger ones. None of the parameters of left radial, right and left sural nerves was found to be statistically significant ($p < 0.05$) (table 4).

DISCUSSION

This study aimed to investigate the effect of age on NCS variables in healthy adults. We found that CMAP amplitudes in all the motor nerves (see table 3), except radial and left ulnar nerves were lower in older age group as compared to the younger ones. In support of our study, Buschbacher in his study, showed decrease in CMAP amplitude of the tibial nerve innervating the abductor hallucis in older age group as compared to the younger individuals.[6] Also, Huang in his study found that the subjects with older age had smaller amplitudes compared to the younger age group.[19] With normal aging, probably there may be decrease in amplitude due to decrease in the muscle mass[1] and decrease in motor unit size. The decrease in amplitude of older age individuals may be due to decrease or loss in the number of nerve fibers.[14, 20, 21] Hennessey et al also found similar decrease in CMAP amplitude of the median nerve in older age group.[15] Similarly, Buschbacher in his study of peroneal nerve motor conduction to the extensor digitorum brevis found decrease in CMAP amplitude in older age group as compared to the younger individuals.[10] Also, in our study smaller CMAP amplitude was significantly related to advancing age.[22]

Kurokawa et al in their study found lower CMAP amplitude in the older age as compared to the younger ones,[11] however, the CMAP duration did not differ among the two age groups. In contrast to their study, our study showed statistically significant effect of age on CMAP duration. The lower CMAP duration in older age group as compared to younger ones could also be due to decrease in muscle mass.

Ulnar nerve conduction velocities were decreased whereas the latencies were longer in older age group in our study. Similar results were seen in earlier studies where all ulnar nerve conduction velocities and distal latencies were significantly related to age.[7] Huang in his study found that subjects with older age had longer latencies than the younger age group.[19] In contrary to our study, the study done by Mohamed et al observed reduction in conduction velocities of the median, ulnar (except sensory conduction), common peroneal and sural nerves across different age groups.[4] This again may be due to minimal effect of aging or small sample size effect. Peioglou et al in their study found weaker relationships between F- wave parameters and age. In our study similar type of F- waves response was seen.[16]

In our study, SNAP amplitudes of median, right ulnar and radial nerves were lower in the older age group as compared to the younger ones.[22] Fujimaki et al in their study also found the similar decrease in SNAP amplitude of the median, ulnar, superficial radial, superficial peroneal and sural nerves with advancing age.[5] This may be due to loss of large nerve fibers in older individuals. In healthy elderly subjects, the reduction in SNAP amplitude is more marked in digits innervated by median, ulnar, and radial nerve. These results agree with those of Dreschler[17] and Cruz.[18] This could be explained by an age related changes particularly in the points where the nerves are more frequently compressed, and by a higher sensitivity to anoxia of the median nerve of the limbs of older people.[17] Falco et al in their study also reported the statistically significant effect of age on SNAP amplitudes.[7]

SNAP durations were longer in older age group as compared to the younger ones in most of the nerves, but was statistically significant in some of them. It may be due to normal process of aging that may lead to main structural changes reported to appear with age such as changes in the fiber membrane; neuronal loss in dorsal and ventral columns;[12,13] fibre loss in peripheral nerves, affecting predominantly the thick myelinated fibres; changes in inter-nodal length and diameter with demyelinating-remyelinating processes.[14, 20, 21]

Saeed et al in their study on sural nerve conduction in healthy subjects found that conduction velocity decreases and latency increases with advancing age.[8] Just contrary to this, our study on sural nerve did not show any statistical significant effect of age. These questions need further exploration.

This study is first of its kind in Nepal and bears strength. The study has created a preliminary normative data of our population albeit in a limited sample. A study with wider age groups and larger sample size will certainly add more strength. It has many similarities and some dissimilarity with the reported NCS variables. The probable reasons could be the true difference among populations, less number of age groups, and small sample size. Nevertheless, the normative data may be used as preliminary working reference while reporting clinical NCS findings. In this way, this study holds a big strength.

Table 3. Effect of age on motor nerve conduction study variables

Motor nerves	Age group	CMAP			F-wave
		Duration (ms)	Amplitude (mV)	Latency (ms)	Latency (ms)
Right median	Younger	8.5±1.88	12.27±3.53	2.71±0.36	24.34±2.41
	Older	6.92±1.31	9.68±3.11	2.68±0.29	23.82±1.48t
	P Value	0.011	0.042	0.798	0.36
Le median	Younger	7.84±1.43	11.8±2.25	2.66±0.25	23.77±1.83
	Older	7.231±1.27	9.27±3.03	2.67±0.2	24.41±1.61
	P Value	0.422	0.014	1.000	0.330
Right ulnar	Younger	8.2±1.31	11.03±2.87	2.18±0.24	25.11±2.64
	Older	7.09±1.54	9.09±2.65	2.25±0.54	24.88±1.79
	P Value	0.018	0.046	0.905	0.851
Le ulnar	Younger	12.06±1.5	10.33±2.96	2.08±0.3	24.48±2.1
	Older	10.56±1.44	8.43±1.82	2.2±0.32	24.88±1.87
	P Value	0.007	0.088	0.187	0.403
Right radial	Younger	13.4±1.52	4.36±1.39	1.96±0.36	NA
	Older	12.8±2.68	4.27±1.2	1.94±0.29	NA
	P Value	0.211	0.798	0.986	NA
Le radial	Younger	13±1.63	4.32±1.98	6.02±0.59	NA
	Older	12.7±2.56	3.74±1.22	2.08±0.38	NA
	P Value	0.313	0.403	0.384	NA
Right tibial	Younger	7.28±1.12	10.05±2.7	10.7±0.99	40.6±4.3
	Older	6.28±0.81	7.94±2.71	11.01±1.3	42.15±6.37
	P Value	0.004	0.033	0.551	0.088
Le tibial	Younger	10.78±1.71	10.98±2.87	10.73±1.18	43.1±2.84
	Older	9.58±1.52	7.75±3.49	10.76±1.07	45.27±3.01
	P Value	0.046	0.003	0.670	0.036
Right common peroneal	Younger	6.99±1.28	4.64±2.15	5.88±0.93	42±3.2
	Older	7.06±2.58	3.29±1.06	5.24±0.79	42±3.7
	P Value	0.297	0.042	0.030	0.817
Le common peroneal	Younger	9.18±1.6	4.38±1.56	5.59±0.6	41±3.5
	Older	7.99±1.64	3.32±1	5.51±1.11	41±3.9
	P Value	0.022	0.042	0.330	0.986

Table 4. Effect of age on sensory nerve conduction study variables

Sensory nerves	Age group	Duration (ms)	Amplitude (µV)	Latency (ms)
Right median	Younger	1.04± 0.14	26.97 ± 10.63	2.17±0.22
	Older	1.10± 0.13	19.01± 7.83	2.18± 0.19
	P Value	0.211	0.030	0.798
Le median	Younger	1± 0.14	25.86 ± 7.8	2.16±0.19
	Older	1.11± 0.14	17.81± 6.89	2.19± 0.18
	P Value	0.007	0.011	0.670
Right ulnar	Younger	1.26± 0.18	16.09 ± 5.85	1.84±0.15
	Older	1.34± 0.17	10.9± 3.44	1.94± 0.21
	P Value	0.046	0.011	0.050
Le ulnar	Younger	1.29± 0.26	13.5 ± 4.9	1.84±0.23
	Older	1.46± 0.14	10.68± 5.57	1.99± 0.16
	P Value	0.046	0.050	0.030
Right radial	Younger	1.05± 0.17	19.72 ± 6.47	1.73±0.24
	Older	1.09± 0.14	14.31± 4.34	1.71± 0.24
	P Value	0.347	0.009	0.905

CONCLUSIONS

Age has de nite e ects on amplitude and duration of motor and sensory nerves. Aging in di erent motor and sensory nerves di ers. Di erent nerves have di erent timing of aging. Without adjustment for this factor, the sensitivity and speci city of NCS will decrease whenusing the same reference data in patients with di erent age. Our results have many similarities and some dissimilarity with the reported NCS variables, and are useful as preliminary working reference for future.

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