Original Article

Nerve conduction velocity and magnitude of action potential in motor peripheral nerves of upper and lower limbs in normal subjects

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Objective: To investigate the nerve conduction velocity and magnitude of action potential in motor peripheral nerves of upper and lower limbs in normal subjects.

Methodology: For this experimental observational study, the motor nerve conduction data were collected from 43 normal healthy volunteers (23 males and 20 females) who had no history of any symptoms related to neuro-muscular or peripheral nervous system disorders. They were divided according to age groups as 20-30 years, 31-40 years, 41-50 years and 50-60 years.

Results: The nerve conduction velocity and the amplitude of action potential were found to be lower in the age group of 50-60 years.

Conclusion: Our designated normative reference values of the motor peripheral nerves can be helpful in diagnosing various neuromuscular disorders. (Rawal Med J 202;45:981-984).

Keywords: Conduction velocity, action potential, peripheral motor nerve.

INTRODUCTION

Nerve conduction studies (NCS), which are part of electro-diagnostic procedures, are used as a diagnostic tool for peripheral nervous system disorders.[1] NCS helps in confirming the presence as well as the extent of the damage caused due to the peripheral nervous system disorders.[2] Motor nerve conduction studies (MCS) help in the diagnosis and prognosis of diseases related to the motor nerves. MCS is performed by electrically stimulating the motor nerves at two or more different sites.[3] The electrical stimulation of these nerves leads to an electrical as well as a mechanical responses which are determined.[3]

The nerve conduction velocity (NCV) can be altered in diseases related to motor neurons.[2] The NCV of the myelinated axon can be 50 times faster compared to the unmyelinated fiber.[4] With the aim of identifying the variations in the NCS, the normal reference values are required.[2,5] Since, there is a lack of the published "normative" or "reference" values from Pakistan, most of the neurophysiology departments in Pakistani setup use either western values or set up their own.[1]MCS can be affected by many factors. The climate, temperature and height of a person may vary in various regions and in different ethnic groups.[6] Therefore, the current study was conducted to develop normative reference values for the nerve conduction velocity and the magnitude of action potential in the commonly used motor neurons of upper and lower limbs for the Pakistani population.

METHODOLOGY

After institutional ethical approval and informed consent by all participants, the data for the study were collected from 43 healthy volunteers including 23 males and 20 females from Department of Physical Medicine and Rehabilitation, Jinnah Postgraduate Medical Center, Karachi, from January to JuIy 2019. The sample size was calculated using the formula $n = (Z\sigma/E)$.[2] Inclusion criteria was absence of any abnormality in the neurological examination and absence of any known risk factors or symptoms of any disease related to nervous system. Exclusion criteria included debilitating diseases, senility and pregnancy.

All were divided according to the age groups; 20-30 years, 31-40 years, 41-50 years, and 51-60 years. MCS were performed according to the previously reported method.[7] The electrical stimulation of the median nerve (motor) and ulnar nerve (motor) in the

upper limb and the posterior tibial nerve and common peroneal nerve in the lower limb by standard recording technique.[7] The variables that were determined included, the nerve conduction velocity (NCV, m/sec) and magnitude of action potential (MAP, mV) from the right side. For the determination of NCS and MAP, a supra-maximal stimulus of 200-250 V was applied for duration of 0.2 milli-seconds. The latency/ time of onset and the amplitude of the action potential were recorded after the action potential evoked and displayed over the oscilloscope. The NCV were determined on the basis of the latency/time of onset and the distance of the two electrodes which were stimulating and recording.

Statistical Analysis: SPSS version 17 was used for analysis. All data are presented in means SD. The age groups and the data of genders were compared using Student's t-test, respectively.

RESULTS

Out of 43 participants, 23 were males and 20 were females of age range from 20-60 years. Each age groups of men: 20-30 years, 31-40 years, 41-50 years, 51-60 years had n=4, n=10, n=7 and n=2 people, respectively. Each group of females: 20-30 years, 31-40 years, 41-50 years, 51-60 years had n=5, n=11, n=7 and n=1 people, respectively. Table 1 shows the details of the nerve conduction study performed on the median nerve (motor), ulnar nerve (motor), posterior tibial nerve and common peroneal nerve. These results when compared to the gender and age groups are presented in shown in Table 2 & Table 3.

Table 1. NCS in median, ulnar, posterior tibial nerve and common peroneal nerve.

No of subjects (n= 43)	Proximal latency(PL) (msec)	Distal Latency(DL) (msec)	Conduction Time (CT) (msec)	Distance (cm)	NCV (m/sec)	MAP (mV)
Median Nerve	7.47 ±0.16	3.36 ±0.07	4.11 ±0.12	32.96 ±0.68	58.33 ±0.74	6.58 ±0.49
Ulnar nerve	7.18 ±0.14	2.81 ±0.06	4.37 ±0.12	25.22 ±0.32	58.06 ±1.28	4.78 ±0.27
Posterior tibial nerve	13.51 ±0.07	5.40 ±0.19	8.12 ±0.36	37.06 ±0.75	46.71 ±1.41	4.35 ±0.33
Common peroneal nerve	09.31 ±0.29	4.64 ±0.11	4.64 ±0.23	25.73 ±0.88	59.44 ±1.26	2.34 ±0.18

Table 2. The nerve conduction velocity and magnitude of action.

Group (years)	Median Nerve		Ulnar Nerve		Posterior Tibial Nerve		Common Peroneal Nerve	
	NCV (m/sec)	MAP (mV)	NCV (m/sec	MAP (mV)	NCV (m/sec	MAP (mV)	NCV (m/sec	MAP (mV)
<30 years (n=4)	58.33 ±0.74	6.58 ±0.49	58.06 ±1.28	4.78 ±0.27	46.00 ±1.20	4.35 ±0.33	59.44 ±1.26	2.14 ±0.37
31-40 years (n=10)	58.32 ±0.66	5.82 ±0.55	57.55 ±1.18	4.85 ±0.24	46.71 ±1.41	4.35 ±0.33	58.54 ±1.11	2.34 ±0.18
41-50 years (n=7)	58.00 ±0.70	6.57 ±0.44	57.06 ±1.00	4.45 ±0.20	45.17 ±1.92	4.20 ±0.46	58.98 ±1.20	2.30 ±0.18
51-60 years (n=2)	56.68 ±0.66 **	4.82 ±0.45 **	55.45 ±1.18 **	4.36 ±0.24 *	41.17 ±1.92 **	2.20 ±0.46 **	53.44 ±1.12 **	2.25 ±0.13 *

Table 3. The nerve conduction velocity and magnitude of action in various age groups of females.

Group (years)	Motor Nerve		Ulnar Nerve		Posterior Tibial Nerve		Common Peroneal Nerve	
	NCV (m/sec)	MAP (mV)	NCV (m/sec	MAP (mV)	NCV (m/sec	MAP (mV)	NCV (m/sec	MAP (mV)
>30 years (n=5)	57.53 ±0.54	6.00 ±0.42	58.00 ±1.00	4.98 ±0.24	46.86 ±1.22	4.55 ±0.53	58.44 ±1.55	2.74 ±0.32
31-40 years (n=11)	58.00 ±0.43	6.02 ±0.51	58.15 ±1.12	4.8S ±0.69	46.41 ±1.11	4.75 ±0.35	58.74 ±1.17	2.71 ±0.16
41-50 years (n=3)	58.00 ±0.20	6.52 ±0.43	57.86 ±1.00	4.48 ±0.22	45.97 ±1.32	4.90 ±0.42	59.00 ±1.00	2.50 ±0.19
51-60 years (n=1)	56.68 ±0.66 **	4.90 ±0.43 **	56.45 ±1.10 **	4.90 ±0.23 *	42.17 ±1.62 **	3.20 ±0.43 **	55.44 ±1.16 **	2.55 ±0.15 *

There was a significant decrease in the NCV of Median nerve ($p<0.01$), ulnar nerve ($p<0.01$), posterior tibial nerve ($p<0.01$) and common peroneal nerve ($p<0.01$) in both gender and in the age group of 51-60 years when compared with other age groups. A significant decrease was also noted in the MAP of Median nerve ($p<0.01$), ulnar nerve ($p<0.05$), posterior tibial nerve ($p<0.01$) and common peroneal nerve ($p<0.05$) in the age group of 51-60 years when compared with other age groups.

DISCUSSION

Ulnar and median nerve are the most commonly accessed nerves for NCS of the upper limb.[3] Recently reported data shows that the range NCV in the median nerve and ulnar nerve were found to be 49.0-68.0 m/s and 51.0-70.0 m/s.[8] Another study reported 58.7±4.3 m/s in median and 61.3±3.9 m/s in ulnar nerve.[1] Another study reported the value to be 59.3±4.0 m/s in set of participants and 56.4±4.3 m/s in another set of participants.[9] However, data reported in Saudi population showed 59±4.33 m/s in median and 59.8±4.86 m/s in ulnar nerve.[10]

Previously reported values of MAP in the median and ulnar nerve show 4.6-15.0 mV and 3.9-11.5 mV, respectively.[8] Another recent study reported the MAP in median nerve to be 10.5±2.8 mV and in the ulnar nerve to be 10.4±2.0 mV.[1] One more recent study shows the MAP in median nerve to be 8.64±1.67 mV in one set of participants and 8.71±1.19 mV in another set of particpants.[9] Data from Saudi population shows, 10.4±2.27 mV in median and 10.9±1.96 mV in ulnar nerve.[10] The values of MAP in our study are in the range reported by Esteves and his group but lesser than other studies.[1,8,10]

A very recent study reported NCV of tibial nerve to be 51.1±53 m/s in one set of participants and 50.1±4.6 m/s in a second group of participants in the posterior tibial nerve and 47.7±3.6 m/s in one set of participants and 47.5±3.2 m/s in a second group of participants in common peroneal nerve.[9] Data reported in Saudi population showed the NCV to be 48.7±4.6 m/s in posterior tibial nerve and 50.9±3.86 m/s in common peroneal nerve.[10]

Another recent study reports the MAP in posterior tibial to be 11.27±2.92 mV in one set of participants and 13.55±3.16 mV in a second group of participants, while, the MAP in common peronial nerve were reported to be 5.59±1.61 mV in one group of participants and 5.41±1.26 mV in a second group of partcipants.[9] Saudi population was found to be having a MAP of 12.1±3.30 mV in posterior tibial and 5.4±2.13 mV in common peroneal nerve.[10] Our decreased MAP in common peroneal and posterior tibial nerve can be attributed to difference in ethnicity and other geographical factors.[11] It is however noticeable, that we found significant influence of age on NCV and MAP as reported previously as well.[12,13,14]

We found that the NCV and MAP decrease after the

age of 50. However, there is a variation in previously reported data. Median and ulnar nerve are more prone to repeated trauma due to repetitive movements with age which can lead to decrease in the values of NCS in upper limb with growing age.[1] Fitzpatrick reported that MAP of median nerve was reduced by 50%–60%, and for the peroneal and tibial nerves by 70%–90% in 70 years people when compared with 30 years old people.[13]

A significant decrease in NCV of common peroneal nerve is also reported with age.[1] This decrease can be due to decreased number of nerve fiber, a reduction in fiber diameter, and changes in the fiber membrane due to natural loss of axons with aging.[14] Motor CMAP amplitudes decline with aging, although this decrease is much less marked than that seen with SNAP.[15] If there is any variation in the position, the values can alter 0.8 and 2.9 m/s.[16]

CONCLUSION

NCS can be useful tool for the diagnosis of various neuromuscular disorders. We report the normative reference values of the motor peripheral nerves which can be helpful in diagnosing and prognosis assessment.

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